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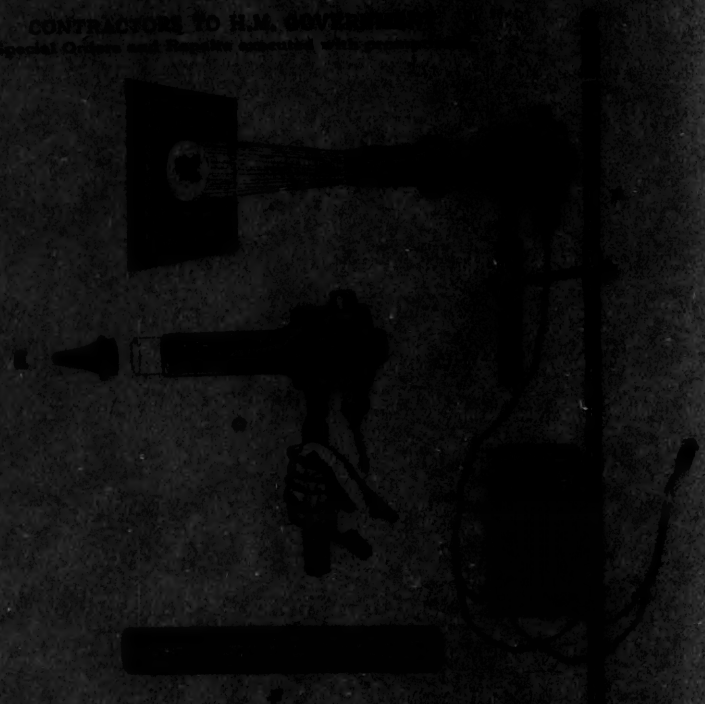

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ROYAL SOCIETY OF MEDICINE, FEBRUARY 13, 1925

DISCUSSION ON MINERS' NYSTAGMUS

T. LISTER LLEWELLYN

THE first sentence of my book on "Miners' Nystagmus," published in 1912, is as follows: "Miners' nystagmus is an occupational disease of the nervous system which is confined to workers in coal mines."

The disease is not a local one confined to the ocular muscles. The symptoms: loss of sight, movement of objects, headache, giddiness, and in more marked cases, anxiety, dreams and mental depression; together with the physical signs; oscillation of the eyes, photophobia, lid spasm and head tremor all point to a general involvement of the nervous system with special manifestations in the oculomotor apparatus.

Incidence of the disease. The examination of large numbers of workmen has shown that 25 per cent. of all men employed underground have signs of miners' nystagmus and this reservoir of "latent" cases must always be borne in mind. There is no evidence that this proportion has increased but Graph 1 shows a very great rise in the number of certified cases and cost of compensation. This increase is due: (*a*) to the payment of compensation from 1908; (*b*) to the alteration of the definition of the disease in 1913;* and (*c*) to the general stresses of difficult economic conditions resulting from the war.

* "The disease known as Miners' Nystagmus, whether occurring in miners or others, and whether the symptom of oscillation of the eyeballs be present or not."

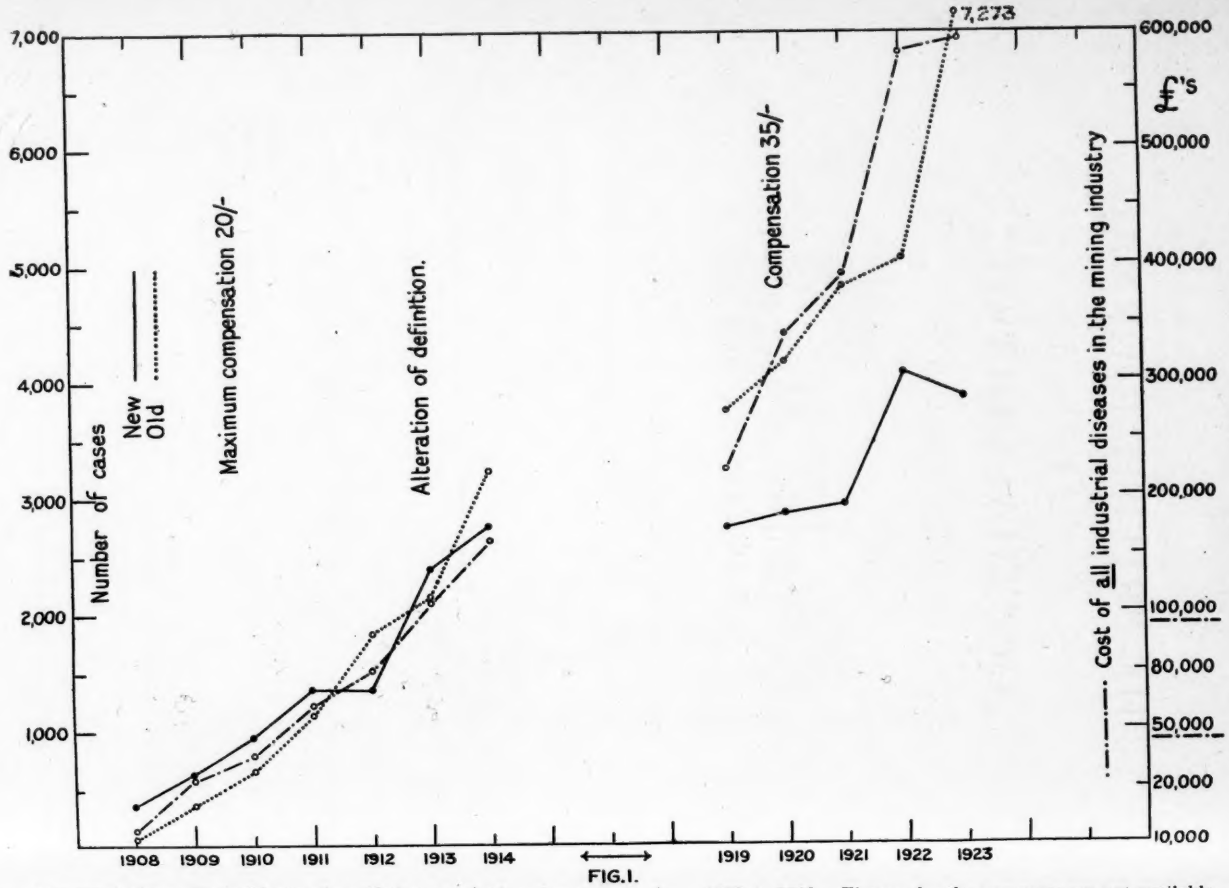

FIG. I.

The graph shows the incidence of certified cases of miners' nystagmus from 1908 to 1923. Figures for the war years are not available.

The incidence of the disease has been shown to vary with the wages and only last month the threatened strike in the soft coal pits of Derbyshire sent up the number of reported cases locally. I must leave the detailed discussion of these factors to Professor Collis.

The disease is of gradual onset and the average duration of underground life before failure is 26 years. Over 81 per cent. of the cases come from men working at the coal face, and it is important to realize that the coal face worker is a highly skilled labourer who aims the blows he strikes with his pick. The more pick work the collier has to do the more likely he is to develop nystagmus. Speaking generally, it is more difficult to work in the coal itself than in the shale under or above the coal or in a band of dirt between two seams. The men also prefer to work on the dull face of the coal rather than on its cross section.

When the disease is established all exercise, bending or looking up, bring out or increase the oscillation. Magnus and de Kleijn have shown that position alone can produce labyrinthine nystagmus which, however, is of a different character from the undulatory oscillation of miners' nystagmus.

Illumination. The Miners' Nystagmus Committee hold the essential factor in the production of the disease to be deficient illumination present in the coal mine. The illumination is deficient for the following reasons:

The low candle power of the lamp used, even the modern electric lamp averages less than one candle power through the shift.

The distance this lamp has to be placed from the working area from fear of damage by the pick.

The shadows thrown by the pillars and bonnet of the lamp limit the area of illumination.

The absorption by the coal and coal dust covered surfaces of 90 per cent. of the incident light. It is the stimulation by *reflected* light which produces vision.

The illumination is unsatisfactory from:

Lack of contrast and absence of diffused light.

The lamp is relatively bright and unshaded and owing to the low height of the working places is often placed on the same level as and shines into the workman's eyes.

I have shown that the average amount of light falling on the coal face varies from 0.02 to 0.2 of a foot-candle, the higher measurements being found in candle pits. Ninety per cent. of this light is absorbed by the coal and the amount of light entering the eye will be between 1/50 and 1/500 of a foot-candle. An illumination of four foot-candles is considered necessary for seamstresses working on black velvet. With the latest electric

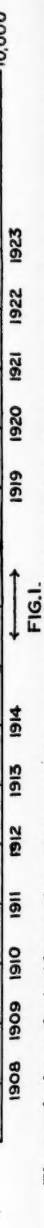

FIG. 1.

The graph shows the incidence of certified cases of miners' nystagmus from 1908 to 1923. Figures for the war years are not available.

lamps and especially with cap lamps the illumination is greatly improved but is still very low when compared with ordinary lighting conditions above ground.

Dark adaptation. Although the eye is capable of receiving light impressions of extraordinary range the process of adaptation to the illumination present takes time.

Graph 2, taken from Ohm's "Miners' Nystagmus," shows that a period of half an hour is required before complete dark adapta-

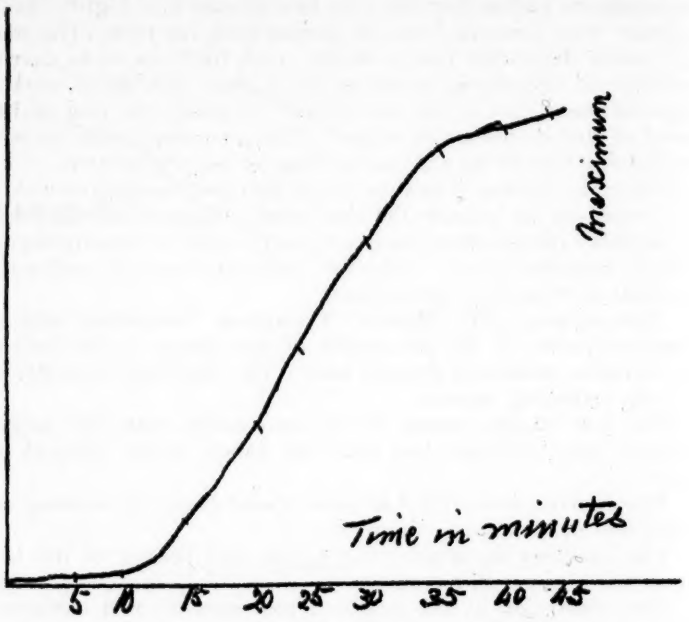

FIG. 2.

Taken from Ohm's "Miners' Nystagmus." Curve of Dark Adaptation reaching the maximum in 45 minutes and showing rapid increase after the first 15 minutes.

tion is obtained. This is what the collier calls "getting his sight." Most colliers suffering from miners' nystagmus show delay in dark adaptation.

Glare. When an improved oil lamp replaced the old Davy the colliers complained of the brightness of the new lamps. In the feeble illumination of a coal mine any direct rays of light which fall into the eye produce inconvenience, which in the case of a nystagmic worker amounts to discomfort or even pain. Tinted and translucent lamp glasses have been introduced to relieve this inconvenience. These glasses diminish the candle power of the

lamp, but are generally held to be more restful to the eyes. Farmer, Adams and Stephenson say that the troublesome after images are less when translucent glasses are used. Dr. Elworthy will give you his experiences at Ebbw Vale.

The general influence of light is shown by the greater prevalence of the disease in winter, the onset of symptoms after dark and the greater recovery rate in the summer.

TIME OF ONSET IN 3,430 CASES OF MINERS' NYSTAGMUS.

Second quarter	...	...	729	42 per cent.
Third ,,	...	...	749	42 per cent.
Fourth ,,	...	...	893	58 per cent.
First ,,	...	...	1,059	58 per cent.

It is not without significance that in the report of the Medical Research Council issued last month, the biological value of light receives great prominence, and that in the index it has the greatest number of references. "Light whose curative powers are so surprising and so little understood."

The measurements of the ultra-violet rays at Hampstead, published daily in *The Times*, show the very great reduction of these rays in December.

I have shown that a collier does accurate work in a very feeble illumination. Dr. Haldane will deal with the physiological aspect.

You may wish to hear the ways in which improvements in illumination are brought about:

1. By increasing the candle power of the lamp. (Last week a colliery magazine printed an advertisement of a four candle-power lamp.)

2. By bringing the lamp nearer the working area. (The cap lamp gives an illumination which may be ten times that of an ordinary lamp.)

3. By the use of shadowless lamps without pillars. (The light given by these lamps resembles that of a candle.)

4. By the use of tinted, translucent or dioptric glasses.

5. By altering the reflecting power of the working places. This can be carried out in the main roads by the use of whitewash, and further in by the use of a light coloured stone dust.

6. By proper lamp maintenance. (Many electric light installation have been ruined by inexperienced lampmen.)

Character of the Coal. There is no doubt that the disease is more prevalent in some seams than in others. For example, the incidence in the black shale seams of Derbyshire is greater than in other seams of the same colliery. In a South Staffordshire pit, this was also marked. In these seams the shale is almost as black

as the coal, there is no contrast, and the illumination is even more deficient than usual.

INCIDENCE OF MINERS' NYSTAGMUS IN A STAFFORDSHIRE PIT.

	Shale	Reflecting Power	Incidence
R. Seam	Black	7	3.3
Other Seams	Grey	19	1.0

The reflecting power of the shale I show you is 12. An old hypothesis, revived by Dr. Robson, is that mine gases are responsible for the disease. The discussion on Dr. Robson's paper is given in full in the "Proceedings of the South Wales Institute of Engineers" (Vol. XXXIX, Nos. 2 and 4). Fortunately, we have in Dr. Haldane the greatest authority on the composition and physiological action of mine air, and I am sure you would rather have his opinion than mine. Dr. Haldane has this year been paid the very great compliment of election to the presidency of the Institute of Mining Engineers, and I can assure you of the enormous esteem and affection in which he is held by all members of the mining profession.

Colliery factors. The older pits, probably from the employment of older lamps, older methods of ventilation, and older men, generally have a higher incidence rate.

The depth of the colliery does not appear to have any marked influence. In thin seams of candle pits the disease is rare, in thick seams of safety-lamp pits the disease is common.

Personal Factors. Men suffering from illness or those becoming inefficient from onset of age, often attribute their symptoms to the presence of miners' nystagmus which they have had for years without experiencing any incapacity. In the last three months the average age of the men certified for miners' nystagmus in one colliery was over 64. Headache and giddiness after stooping are symptoms common to miners' nystagmus and to high blood pressure, and these conditions are frequently mistaken the one for the other.

Ill health, fear of unemployment, poor wages or quarrels with the management must all irresistibly point out to the man the wisdom of following the path of least resistance attained by certification. But over and above these cases some men fail more quickly or suffer more incapacity than others. Percival thinks there is an inherited predisposition possibly the result of the inbreeding so common in pit villages. Ohm thinks there is an inherited deficiency in light sense which shows itself in a failure of dark adaptation. I think there is some justification for these contentions, but it must be remembered that as sons follow their fathers' occupations, members of the same family will be frequently affected, and the large proportion of latent cases in

the pits makes it clear that susceptibility to the disease is probably universal. I once saw a father and three sons with signs of the disease, the father alone remained at work.

The factor which determines the onset of incapacity in many cases is the mental make-up of the individual. The experiences of the war brought prominently before our notice, the fact that many men are unable to stand the stresses of danger, discomfort, or uncongenial surroundings without breaking down. The development of a neurosis enables them to escape, and if in addition to freedom from uncongenial work the release is associated with pecuniary advantages the motive is doubly strong. These men may or may not show the signs of miners' nystagmus, but the incapacity they suffer from is a neurosis. The great increase in the number of certified cases is partly explained by the inclusion of these men. Miners' nystagmus is frequently mimicked unwittingly, and readily spread by suggestion. It is quite easy for a medical man to turn a latent case of nystagmus into the manifest variety by the disservice of suggestion. Individual pits and even districts have a good or bad record for the incidence of the disease in the same way as during the war battalions with good morale had few cases of "shell shock," while other units badly led or trained had a high incidence.

I wish to be quite clear—most cases of miners' nystagmus are straightforward and show no evidence of a neurosis. In a second group marked signs of miners' nystagmus are associated with neurotic symptoms, while in a third group the neurosis is dominant, but is accompanied by slight or indefinite signs of miners' nystagmus. Neurosis is common and underground workers, numbering one million men and forming an appreciable proportion of the total population, must have their quota of this undesirable condition. When a neurosis is present it differs in no way from the neurosis found in other conditions and its treatment is the same.

The provision of suitable work has an important influence on the recovery rate, and consequently on the incidence of the disease. If nystagmic men are allowed to remain idle and given no opportunity of working on the surface they all rapidly deteriorate and become unemployable. In this they differ in no way from pensioners and other cases in receipt of compensation. If, however, they are sympathetically treated and encouraged to work the recovery rate is high.

Early in 1923 I made an assessment of 650 cases from one district and give below in tabular form: (*a*) What the men were doing at the time of examination; (*b*) what I thought they should have been doing; and (*c*) in the last column, what they actually were doing in January 1, 1924.

	Time of Examination	Assessed Condition	1924
Not working	468	270	167
Working on surface ...	162	154	174
Working underground ...	20	226	176
Recovered	—	—	133

These recovered men accepted the medical finding that they had recovered from the disease. Most of them were working on the surface, but others were incapacitated by old age or illness. In the same district in January, 1925, including fresh cases arising in the two years 1923 and 1924, 410 men were on full earnings.

Let me finish with a note of hope. High as were the figures for new cases in 1923, they are fewer than those of 1922, and I believe the fall will be continued in 1924. (Figures not yet available.) All colliery owners are alive to the importance of adequate illumination and large sums are being expended in the installation of new lamps which are now looked upon as "primary machinery." Above all let us hope we are returning to normal conditions.

J. S. HALDANE, F.R.S.

I THINK that we may now regard it as clearly established that miners' nystagmus is brought about by using the eyes for guidance of muscular movement when the absolute (not relative) differences in luminosity of the objects seen are extremely low. I do not propose to discuss the evidence in favour of this conclusion, or against other theories as to the cause of miners' nystagmus, but only to draw attention to a certain physiological peculiarity of vision where the illumination is extremely feeble. It seems to me that this peculiarity furnishes a key to the understanding of how miners' nystagmus is produced.

Within wide limits of actual physical illumination the acuity of vision is practically constant, but begins to fall off seriously with low illuminations, till with sufficiently low illuminations we cannot even distinguish a white from a black object, however large the objects may be. It is also well known that with good or even very moderate illumination the acuity of vision is much greater in the centre than at the periphery of the field of vision, but that with very low illumination this is no longer the case, vision with the fovea becoming finally less acute than with peripheral parts of the retina. It is not, however, to this point that I wish to draw attention, but to a quite different one.

One great peculiarity of foveal vision with sufficient luminosity is that the impression in consciousness of an object on which the eye is fixed is a lasting one : we continue to see it. In the periphery

of the visual field, on the other hand, the objects which are at first perceived fade rapidly out of consciousness when the eye is fixed. With the slightest movement in them, or alteration in their luminosity, they are, however, again perceived. If, for instance, we fix our eyes steadily on a fairly bright star, the surrounding stars fade out of our vision, except those which are twinkling. But in the twinkling stars the twinkling, which is, in the physical sense only a variation in luminosity, becomes enormously exaggerated; a twinkling star in the periphery of the visual field, with the eye fixed, disappears completely from vision during the intervals of twinkling, and seems to blaze out suddenly at each twinkle.

Now, with very low luminosity, foveal vision loses completely its lasting character: an object, at first seen, fades rapidly out of consciousness, so that it can no longer be fixed. With foveal vision the conscious impression is now even less lasting than with peripheral vision. The result of the impossibility of fixing the eye on the object is that the eye wanders about, picking the object up momentarily with the fovea, and losing it again. This must be a very fatiguing process, and it seems to me that in all probability the fatigue thus induced is the origin of the ultimate disturbance in ocular co-ordination which constitutes miners' nystagmus. We might, perhaps, alternatively regard miners' nystagmus as a tendency to a bad habit induced by the fact that with very low illuminations the eye is always moving about.

The fact that foveal vision fades so rapidly can easily be verified experimentally in a suitably darkened room. The room must, it is true, be very dimly illuminated; but it has to be remembered that in a coal mine the luminosity of everything is extremely low, owing to the presence of coal dust everywhere, except in places where a light-coloured stone dust has been applied recently. With ordinary hand safety-lamps the illumination of a working place is not only very low, but the actual luminosity is extremely low, as shown by Dr. Llewellyn's measurements.

There is no nystagmus among coal miners where oil cap lamps are used, as is still the case in many coal mines in Scotland; nor in American coal mines, where the only safety-lamps used are electric cap lamps. With cap lamps the illumination of a miner's working area is, of course, far greater, since the lamp is so close up; and it seems clear that unless the illumination is greatly increased, either by the use of cap lamps or by hand lamps which are much more powerful than those at present in use, nystagmus will continue to be prevalent among coal miners in this country. I think that it will be found that the illumination required to prevent nystagmus is such as will permit of lasting foveal vision, and, therefore, of fixation of the eyes on the objects seen. This fixation is necessary for the proper guidance of any tool a miner is using.

To judge from rough observations on different individuals, the threshold illumination below which lasting foveal vision becomes impossible varies considerably in different persons. Perhaps this variation is related to varying liability to nystagmus. When old-fashioned oil safety-lamps are used about half the miners working at the coal face show symptoms of nystagmus, though only a very small proportion of these cases are associated with any serious inconvenience. Mr. Pooley has shown that the tendency to nystagmus is not dependent on defects of accommodation, but it may well be dependent to a considerable extent on variations in the threshold for lasting foveal vision. Visual acuity is, of course, greatly affected by defects of accommodation, but I do not think that it is falling off in visual acuity, but the greatly diminished lasting power of foveal vision that leads to nystagmus.

As I am particularly familiar with the gases present in coal mines and their physiological actions, and as it is still sometimes believed that miners' nystagmus is due to these gases, I should like to take this opportunity of again saying that so far as I can see the action of abnormal gases can have nothing whatever to do with miners' nystagmus.

H. S. ELWORTHY

THE amount of light a coal miner has to work with is really very small, mainly because of the absence of colour in coal, that is to say, its general blackness, which has the effect of absorbing from 90 per cent. to 97 per cent. of the light thrown on it, so that only some 3 per cent. to 7 per cent. of it is reflected back. It is, therefore, of the greatest importance to him that what light he has should be of a suitable quality.

What impressed me most in coal mines was the blackness, and gloomy surroundings rather than the smallness of the light, and I thought it desirable to introduce light colours into the mines in order to relieve the eye of the monotony of blackness, and to give it more variety. That is to say, in my paper read before the Monmouthshire Branch of the B.M.A. in 1910, instead of asking for "more candle power" I was asking for "increased illumination," but in a different manner.

Illumination is not merely a matter of candle power, it depends just as much on the surface reflecting the light back into the eyes —light colours reflecting more, and dark ones less, so that in simply measuring the candle power of lamps we do not get the exact measure of the "illumination"—we only get one factor of it.

On measuring the colour, surface brightness of the coal, and the candle power of the lights used, and multiplying them together,

I got what I called "the chromophotic index" of the mine, and with this compared what really amounts to a more exact measurement of the "illumination" of one mine with another.

The reason for including the surface brightness of the coal as one factor is that "dead black" with a polished surface, such as the facets on coal, does reflect a little light, whereas a "dead black" mat surface reflects none at all; and when coal has become covered with fine powdery black dust it resembles a black mat surface. Two pieces of coal may be of the same colour, but if one is clean and bright and the other dull and powdery, one will reflect more light than the other.

Then, as to colour. Anyone looking at the slag tips of various coal pits can see at once that there is a great deal of difference in the colour; some is much lighter than others, and this has a distinct effect on the illumination. When the slag is as black as the coal, I expect that pit to be more likely to produce nystagmus.

At the Oxford Congress in 1912, while again asking for "more illumination"—not necessarily higher candle power—I expressed the opinion that if in such a place as the Dolcoath tin mine there were only one-tenth of a candle power in the lamps, there would be no nystagmus, as more than half the light thrown on the surface was reflected back, owing to its lighter colour.

Sir Josiah Court had asked for more candle power in his paper in 1891 and at this Congress did so again, and the Congress generally agreed with him.

At about this time the "C.E.A.G." lamp was introduced, and later the "Oldham," both with an increased candle power, but although they have diminished nystagmus in places, they have not yet abolished it.

Owing to the cost, or to other reasons, my plan of putting colour into mines has not been accepted, unless it has been in the roadways, where the advantage of whitewash is very evident, but it is at the coal face that better illumination is wanted.

Now, with regard to the quality of the light for coal mines. My attention was first drawn to this when making examinations on candle power and colour. It was then that I noticed that while in a mine the candle power of the lamp was very much reduced, sometimes to only 0.1 c.p., the flame of it remained the same size, but the yellow and orange rays had gone, leaving only a whitish blue flame, and on returning to fresh air these yellow rays reappeared. As I sometimes made examinations at night, after the men had left work, it was all the more striking to see the yellow flame after seeing the ghastly whitish blue one in the mine. The relief to the eye was remarkable, and gave quite a pleasurable sensation. I did not at first realize the full significance of it, for

not only was the candle power reduced, but the quality of the remaining light was entirely changed.

When the "C.E.A.G." and "Oldham" lamps first appeared, both of them with an uncomfortable bluish light, it set me wondering why anybody should put such a light into a coal mine.

On looking at different lights I found those from candles, oil lamps, and carbon filament lamps gave the greatest comfort, while blue and violet lights were the most irritating to the eyes. You all know what an unsatisfactory bluish light was given out by the electric arc lamp, and how this has generally been abolished for lighting purposes.

I believe it is recognized as necessary to protect the eyes of people working at electric welding, travelling in snowfields, or working with ultra-violet rays. These rays are said to cause severe pain in the head and eyes which may last for days, and in some cases bring about permanent retinal damage with central scotoma.

In making analyses of light, I have found the greatest difficulty is in measuring the blue. With a small spot of light, which can only be seen with the retina outside the fovea, the measurements have to be made quickly. If one continues to look at it for a second or two longer, it disappears. The visual purple or the retina is exhausted, and nothing is to be seen until the eye is moved, so that the light may fall on another place, when it appears again. The same applies—to a less extent—to the red, which also has to be measured by using a peripheral part of the retina, but it does not disappear so rapidly, while the green can be measured by looking straight at it.

The exhaustion or injury of the retina by violet light seems to be a reasonable explanation of the movements of the eye in nystagmus. A thing that puzzled me at first was—when nystagmus patients looked at me, or my finger, sideways instead of directly—until they explained that they could not see if they looked directly, so had to look obliquely. They had for the time lost their central vision. There seemed to be no good reason why the simple diminution of light should bring about this result, but the focussing of violet rays on the fovea may well account for it.

Only last week I met my successor, Dr. Mills, and asked him if he remembered in the old days those cases that had lost their central vision, and whether such cases occurred now? He remembered them quite well, but said they were nothing like so common now. But even now some of those severe cases that never seem to get any better have it, and he knows of three or four cases in our district. Knowing that miners in bad air with oil lamps were getting a relative excess of blue and violet rays, and that in some severe cases of nystagmus the burning pain in the head and eyes (which I did not regard as a neurosis) persisted

for years after they had left work, even when not using their eyes, and also that in some cases central vision was lost, while no cataract or corneal opacity was observed, I got the idea that perhaps, after all, these violet rays might be responsible for nystagmus.

At the meeting of the Illuminating Engineers in 1920, I expressed this as a strong suspicion. There seems to be a certain similarity between the symptoms of eye injury from ultra-violet rays, and eye injury in some cases of severe nystagmus. In the one case, from a massive dose of short duration, and the other from small doses repeated over a long period, just in the same way one may get an X-ray burn from one massive dose or from a number of small repeated doses. This is an opinion that is quite open to controversy, but it set me thinking about the undesirable qualities of bluish light, and how to get rid of them; and moreover, it seems to fit in fairly well with the facts, so that at present I am still more inclined to the theory that miners' nystagmus is caused by violet or ultra-violet rays from defective lighting. Having come to this conclusion I asked for a standard of quality as well as increased illumination in coal mines.

Analyses of various lights, made by photometry, and using light filters that divide the spectrum into three approximately equal parts: red, green (which includes yellow), and blue (which includes violet) gave the following results.

ANALYSIS OF LIGHTS.

	Red per cent.	Green per cent.	Blue per cent.
Marsaut lamp in fresh air, c.p. 0.48 ...	71	22	7
Marsaut lamp in mine air, c.p. 0.21 ...	69	20	11
C.E.A.G. lamp	55	31	14
Oldham lamp with clear glass	52	31	17
Oldham lamp with tinted glass	51	38	11
Carbon filament lamp	67	27	6

A Marsaut lamp in fresh air with a candle power 0.48 had 71 per cent. red, 22 per cent. green, and 7 per cent. blue, but when taken into a mine and only about 600 yards from the pit shaft, the candle power was 0.21, the red was 69 per cent., green 20 per cent., and blue 11 per cent., thus confirming the naked eye observation that there was an increase in the blue and a diminution of the yellow.

Analyses of the lights from the "C.E.A.G." and "Oldham" lamps show that both these, while giving greater candle power, as a matter of fact gave a worse quality of light than the oil lamps they replaced. That, I think, is the reason of their failure to prevent nystagmus. Analyses of light reflected by coal of different kinds

show that steam coal reflects twice as much blue as house coal. This has been confirmed by Dr. Llewellyn.

The chromophotic index of illumination in house coal and anthracite pits that I have examined is much higher than in steam coal. I think that is why there is so little nystagmus in them. Now, as I am told, the cost of colouring the coal face would be prohibitive, some other remedy must be found, and we may ask how we may best improve the lamps?

So far, manufacturers seem unable to make a lamp that will give a light similar to a carbon filament, which I consider the ideal to be aimed at. At the meeting of the Illuminating Engineers, Dr. Ettie Sayer mentioned a lamp which gave a yellow light, free from all blue rays, and although it was 800 candle power it could be used 14 inches away from the eyes without any irritation, in fact she said it was soothing. As the eye is naturally made to work with a certain amount of blue, it does not seem desirable to exclude it altogether, but merely to cut down any excess. The carbon filament seems quite suitable. As a substitute for this we can filter off some of the blue rays by using tinted yellow glass.

The Oldham makers were asked to make a glass which would render the light similar to the carbon, with only 6 per cent. of blue, but up to now they have not quite succeeded in making that particular quality of glass. What they have done reduces the blue from 17 per cent. with clear glass to 11 per cent. with the yellow glass. This is a step forward, but I should like to see it reduced to 5 per cent. or 6 per cent.

The stage we have now arrived at is this: We have rather a higher candle power, but still not high enough, and, comparing the light with that from a Marsaut lamp in a mine, there is just about the same amount of blue, decidedly more yellow, and less red. On the whole it seems a considerable improvement.

The difference between the lamp with a yellow glass and a carbon filament is easily seen by putting one of each, side by side. One can see that there is more blue and more yellow, but there is lacking the slight tinge of red seen in the carbon—the light from the yellow lamp looks somewhat "cold," and decidedly less comfortable than the carbon. The Ebbw Vale Company began putting these yellow glasses into their mines in the autumn of 1923, and have now had one clear year with all the miners supplied with them. At first one was given to each man with nystagmus, but they very soon began to complain, not of the yellow glass, but of the glare from the lamps with clear glass, so all the lamps were fitted with tinted glasses as fast as they could be made. The result is quite satisfactory, considering the facts that we have not the exact quality of light we want, but only an approach to it, and the mean candle power is still below the minimum required.

It is perfectly useless to delude oneself with the idea that because a manufacturer says his lamp gives 1 candle power, that, therefore, the collier gets 1 candle power at his work. He gets nothing of the sort. If you measure the light from one of these filament lamps with the filament broadside on, you get the maximum, then if you turn it at right angles when the filament is end on, you get the minimum, which is just a fraction over half the maximum. The mean candle power is therefore three-quarters at most, and we can only safely assume that it is this average that the collier gets, and he only gets that when the filament of the lamp is fairly new, when the glass is clean, and when the accumulator is giving its full voltage.

I have estimated that the minimum candle power required to bring the chromophotic index of a steam coal pit up to the margin of safety, *i.e.*, 500 is 0.9 candle power, and Dr. Llewellyn has fixed it at 1 candle power. I think we should both prefer to have a candle power well above this minimum.

In the group of Ebbw Vale collieries, employing 4,600 men underground, the number of nystagmus cases certified in 1914 was 42, when they were using clear glasses, while in 1924, the first year in which yellow glasses were used, there were only seven cases. This group includes the pit which I always regarded as our worst, and last year there was not a single case from it. There has been no other change, the only difference is the substitution of the yellow glass for the white. A number of men, known to have nystagmus have worked all the time with this light. It is well known that when work is regular and wages high, fewer cases are reported, and vice versa.

As an example, in 1917, when wages were high and work regular, in one of our groups employing nearly 5,000 men, there were only three cases. It is the financial position of the miner that makes it so difficult to estimate whether he is really unable to work, or whether he prefers to go on compensation rather than earn the wages he can.

Referring to last year again, not a period of high wages, we have two groups of two pits each, working back to back, two in one valley and two in the next, and both groups employing about 2,000 men; the conditions, seams, yellow lights, etc., are identical, and there is little difference in the air. The analysis is as follows:

	CO_2	CH_4	CO
In group 1 there was in Big Vein East...	0.15	0.23	Nil
And in Black Vein	0.18	0.78	Nil
In group 2 in Black Vein	0.20	0.33	Nil

No carbon monoxide was found in either, nor has it been found in any of our mines.

In No. 1 group the work was regular, and no new cases were reported, while in No. 2 group there was a good deal of short time through want of trade and there were 16 cases. One of the pits of No. 2 group had to be shut down, and 14 days' notice was given, with the result that before the notice had expired six cases were notified from that pit. The explanation is that a workman would be better off on compensation than if working only three days a week.

It seems a reasonable inference that if this No. 2 group had been working regularly, like No. 1 group, there might have been no cases at all. But, with only one year's experience, one cannot speak with certainty. On inquiring of colliers who have used the yellow glass, I was told that they like the soft light, and dislike the hard glare of the clear glass. All they want now is a greater candle power, and this the Ebbw Vale Company intends to supply in the near future without unduly increasing the weight of the lamps. Letters of appreciation have been received from miners who have nystagmus and who continue to work.

On making further inquiries from some rather young colliers, they described the yellow glass as unsatisfactory, and said they would rather go back to the clear glass. That when the clear glass lamp was bad, they could still see to work with it, but with the yellow one the filament looked dull red, and they could not see at all. They admitted that the clear glass had a glare, and the other had not, and thought that if the candle power was increased the yellow would do, but they did not seem to like the colour much.

Now, does this theory of ultra-violet rays fit in with the facts? Taking the common candle or filament carbon lamp as a standard, there is evidence that in a mine, either with an oil lamp or with a metallic filament lamp, there is more blue and violet in the light. Steam coal reflects more blue than house coal. Violet light falling on the retina quickly exhausts or injures it, so that it is necessary to move the eye in order to see and to avoid irritation and damage. Naturally, the easiest way is for it to move round so that the rays fall on successive spots around the fovea and this rotatory form is the commonest.

Loss of central vision can be accounted for by too long exposure to ultra-violet rays. Workers in photograph developing never use blue light; those in electric welding and travellers in snow use yellow or amber glasses to cut off these rays.

Ebbw Vale miners, since using these glasses have suffered much less from nystagmus, and with the correct glass, and candle power will in all probability not suffer at all.

H. EUSTACE MITTON, M.INST. C.E.

I JOIN in the debate on miners' nystagmus, through the introduction of Dr. Llewellyn, and the invitation of your Secretary.

As one who was born in a mining town in Durham, and spent all the first part of my life amongst the miners, together with over thirty years of close connection with the miners in my profession, I am perfectly satisfied on two points:

First.—Nystagmus is due to the strain of working with inefficient light.

Second.—Men differ enormously as to the effect, and whereas one man can go through life working with the strain upon him without any serious effect, another man after a time develops the disease, which, if not checked in its earlier days, gradually increases to an acute form.

When one considers the earlier history of mining, and the inefficient lighting of the mines, and has known hundreds of fine old men who have worked from their boyhood in these conditions without the slightest eye trouble, it confirms fully the above opinion.

In 1890, nystagmus came prominently forward in the Midland coalfield, due to a controversy which arose between the late Inspector of Mines, Mr. Stokes, and the Derbyshire Miners' Association, as to whether the light by which the miners worked was the cause, or the conditions of the work which called for the miner to lie in a recumbent position when holing the coal.

Sir Josiah Court, one of the finest physicians in this district and who I am delighted to say is alive to-day, took the matter up. He devoted an enormous amount of time to the subject, and the result of his investigation is fully recorded in the "Transactions of the Institution of Mining Engineers," Vol. XLVI, and in the recently published book edited by Mr. Batley, of "The Sheffield Telegraph."

I do not propose to reproduce any part of Sir Josiah's findings which have been read by myself and others connected with mining with the greatest interest.

As to the working conditions of the miner, I do think the holing of the coal aggravates the disease, simply because in this particular form of work the miner is in a position where he cannot get his light on the point he wants to strike, and consequently is straining his sight.

Let me say this, when Sir Josiah's paper in the "Transactions" came forward, I criticized his finding on the grounds that at a large colliery in the Midlands at that time the men worked with candles, and subsequently when figures became available as to

DECEMBER, 1913, AND DECEMBER, 1924.

		Number incapacitated.			Number employed underground	Per cent. affected of Persons employed underground.			Remarks.
		Fully	Partially	Total		Fully	Partially	All Cases	
1.	1924	—	3	3	801	—	0·37	0·37	Electric since July, 1920. Increase due to additional men.
	1913	—	—	—	640	—	—	—	Oil.
2.	1924	—	—	—	256	—	—	—	Oil. No case has ever been known at this pit.
	1913	—	—	—	153	—	—	—	Oil.
3.	1924	—	2	2	368	—	0·54	0·54	Electric since March, 1924. Increase due to additional men. Effect of better lighting cannot yet be told as period too short.
	1913	—	—	—	179	—	—	—	Oil.
4.	1924	—	6	6	602	—	0·99	0·99	Electric since July, 1920. Increase due to additional men.
	1913	1	3	4	470	0·21	0·63	0·85	Oil.
5.	1924	1	3	4	567	0·17	0·52	0·70	Electric since July, 1920. This pit shows a big increase and is receiving very special attention. The same as No. 4.
	1913	—	1	1	391	—	0·25	0·25	Oil.
6.	1924	—	2	2	210	—	0·95	0·95	Oil. Here is a case of an open light pit going to oil. Number of men —, increase very small.
	1913	—	—	—	197	—	—	—	Candles.
7.	1924	—	—	—	468	—	—	—	Electric since March, 1923. No case ever known here.
	1913	—	—	—	179	—	—	—	Oil.
8.	1924	—	—	—	236	—	—	—	Oil and candles. No case ever known here.
	1913	—	—	—	249	—	—	—	Candles.
9.	1924	2	2	4	917	0·21	0·21	0·43	Electric since July, 1920. Increase due to additional men.
	1913	—	1	1	347	—	0·28	0·28	Oil.
10.	1924	5	13	18	2,490	0·20	0·52	0·72	Electric since January, 1917. Very fine example of effect of introducing better light.
	1913	8	19	37	1,683	0·47	1·72	2·19	Oil.
	1924	8	31	39	6,915	0·11	0·45	0·56	7 Collieries Electric. 2 ,, Oil. 1 ,, Oil and Candles.
	1913	9	34	43	4,488	0·20	0·75	0·95	Oil and Candles.

the number of persons employed below ground suffering from nystagmus, this colliery had a large percentage. I have now altered my opinion, from years of experience, and the table I produce with these remarks, will, I think, substantiate my view. You cannot get reliable data on this important subject by comparing the ebb and flow of nystagmus cases at any particular colliery, because of the constant changing of men.

It is well known to all mining engineers that in developing a new seam, the manager is pressed for output by harassed directors who have spent large sums of money in opening up the mine, and naturally want to deliver to their shareholders some small return on the outlay. The result is, all are taken on who come, and consequently many affected with the disease are engaged.

I now give a table showing the actual result of introduction of better light:

At the present time I have eight collieries employing 7,000 men underground, under my personal supervision. The incidence of miners' nystagmus at the end of December, 1924, was 0.56, and at the end of 1913 it was 0.95. I attribute the decrease to the improvement of illumination. At one colliery this decrease is very striking: from 2.19 in 1913 where oil lamps were used to 0.72 now. Electric lamps were introduced in this colliery in 1917.

It is noticeable in taking all the collieries enumerated, that the total shows a very remarkable decrease, whereas individual collieries show an increase. This is due to the increase in the number of men at certain pits, where, by developing the same, men are employed who, in my opinion, have the disease already in their system. The main thing to look at is the decrease in the total.

We have to-day established a system of lighting under this company of 0.87 candle power by electric light. We want to go further, but are handicapped by weight of lamp. The present miners' electric lamp gives eight hours burning on a weight of 6 lb.

In considering oil lighting *v.* electric, there is a very important matter which affects the light for the miner, due to variation during the shift of the oil lamps. The 1911 Coal Mines Act makes it imperative that there are two gauzes in every lamp now instead of the single gauze.

The result is that the burning of the oil lamps did not give such a brilliant light as before 1911, due to the above. Further, the lights on being taken into the pit were affected by the atmosphere, due to the rise and dip of the mine. In certain of the mines under my control there is a gradient of 1 in 14, and the result was, when the men took the lighted lamps and went into the pit, the men who worked in the rise district found that after they had gone a certain

way in the mine, their lamps were reeking, due to the flame increase. This meant, of course, that the gauze was affected, and the result was, the men during the shift were working with an inferior light. In the case of the men going to the dip, after proceeding a short distance they would notice that their lights got dull due to the flame decreasing, with the result that they used the trigger, raising the flame slightly, and in many cases gave more light than was necessary, and before work commenced they had got a gauze slightly smoked.

With the electric lamp, of course, where you get an efficient cell, you get a continuous burning during the shift, which is a great advantage.

In travelling the faces quite recently, I was very much struck with the diffusion of light from seven electric lamps at various points in a long wall face of 44 yards, compared with the yellow glow of an oil lamp which was also in use at the mine.

In conclusion, I arrive at this:

The makers of lamps want, with the Mines Department, to endeavour to get the light to a continuous one for the shift of one candle power.

The coal owner wants a diffused light, so that the miner has light to see the object he is intent upon.

The miner who finds he is affected by nystagmus, should endeavour, as far as he can, to continue active exercise in working in some capacity, and the manager should assist him. It is, in my opinion, fatal for a man to give up exercise, because there is no doubt extra smoking and any other cause aggravate the disease.

MILLAIS CULPIN

A CONSIDERATION of the psychopathological aspect of this disorder may enable us to bring into accord a number of apparently unrelated phenomena. Nystagmus *per se* does not disable a man; symptoms admittedly psycho-neurotic are often the actual cause of his disability. And I must point out also that those ocular symptoms associated with the nystagmus are typically psycho-neurotic: photophobia, blepharospasm, head tremors, extreme convergence on examination of the eyes, and night-blindness (which may be a re-statement of the patient's fear of the dark, though epidemic night-blindness in soldiers was described by Hector Gavin in 1847) were familiar during the war as mental results of such stimuli as gassing and burial. Dr. Rivers demonstrated the identity of the non-ocular symptoms with those following the strain of warfare. As a matter of practical and historical interest we may note that most of the symptoms of

shell-shock and of miners' nystagmus—except the oscillation of the eyeballs—were described by Herbert Page in his book on "Railway Injuries," published in the eighties. It needed the controversial efforts of Page and Furneaux Jordan, extending over several years, to demolish the physical hypotheses that had been propounded to explain the symptoms of "Railway Spine." In spite of this experience, when similar cases occurred *en masse* in the war we had again a crop of physical hypotheses; men were given wound stripes for hysterical conditions, and it took a Parliamentary Commission finally to establish the mental origin of shell-shock. These episodes indicate a tendency in medicine against which we must be on guard.

Now let us consider miners' nystagmus as a psycho-neurosis and see how far this will throw light upon it.

First, what sort of man acquires it? Sir Frederick Mott found a history of pre-existing psycho-neurotic symptoms in 80 per cent. of his war cases; my own figures give 57 per cent. This personal element in any psycho-neurosis needs investigation, and an actual example will indicate the kind of material that may be found if it is looked for. I give the patient's own words:

"I'm naturally of a nervous temperament, I'm a bad sleeper and have nightmares. I shake when I am worried and am always anxious whether my work is right or wrong. If people stand in a train I wonder whether the floor will go through. I have a fear in the dark as if someone were following me. If I went to a picture show I should go wet all over and not sleep afterwards. I suffer from anxiety and palpitation in tube lifts. I can't write if I am watched. I had a nervous heart as a child."

In this case many of the symptoms were present before the onset of a disabling psycho-neurosis. If the patient had been a business man he would probably have been treated for nervous exhaustion; an accident would have been followed by "traumatic neurasthenia"; if a soldier up the line he would have had shell-shock, whilst if he stayed at the base he would have developed that nystagmus of the heart known as D.A.H.; if such a patient were a woman she would suffer from spasmodic dysmenorrhoea and a nervous breakdown at the menopause. The patient was a man and finally suffered from a typical occupational cramp. He will stand for one type which will acquire whatever form of psycho-neurosis is offered by the environment, and I venture to suggest that if he had worked in a coal mine he would now be receiving compensation for miners' nystagmus.

The onset of the disease often conforms to well-known types. Dr. Llewellyn states that trivial injuries precipitate the disorder, and also quotes cases in which the analogy with shell-shock cries aloud. For example, one man said: "Whilst holing in the coal

a blister exploded in my face, my eyes got bad at once and I had to be led out," and another: "I was buried under a fall, my eyesight failed at once. I had no trouble before."

The observation that "injury to the back is frequently followed by the onset of nystagmus" indicates a relationship to another old friend, and the influence of compensation is another obvious link.

The disappearance of nystagmus as the more frankly mental symptoms increase has its parallel in war experience and in civil life. The mutisms, tremors, stammers, paralyses and what not, tended to disappear and to be followed by symptoms like those described by Dr. Rivers.

Dr. Frederick Robson notes that ex-service men "soon contracted nystagmus on resumption of work below ground." (*Industrial Welfare*, July, 1923, p. 193.) A similar thing happens if any other occupation neurosis is available to them.

One of the strongest emotional factors in the psycho-neuroses is *fear*. Measured by its fatalities mining is the most dangerous trade, and, turning again to Dr. Llewellyn, we find him stating that timbermen and repairers frequently suffer from the disease, and, by a notable intuition, in the same paragraph he stresses the particularly dangerous nature of their work. The contrast between naked-light pits and safety-lamp pits is not only one of illumination, but of danger; in fact, that is the primary contrast. Knowledge of the presence of gas may have effects not to be measured by the physiologist. In short, the frequent identity of the mode of onset of nystagmus with that of shell-shock points clearly to the common factor—the threat to personal safety—universally recognized in one case and almost universally ignored in the other.

Miners' nystagmus, then, shows no difference from other widely occurring psycho-neuroses except in the predominance of one symptom, which is not constant and is not correlated with the severity of the other symptoms. This symptom is part of the general state, and like that, is closely correlated with bad illumination. I have suggested that this correlation may be an indirect one, with the presence of danger as the middle term, though we may agree that the bad illumination directly decides the ocular form of the most conspicuous symptom. But the gloom of the coal-bearing nether regions must have its mental effect, and I would point to two photographs in Dr. Llewellyn's report to the Medical Research Council showing the difference of illumination after a roadway had been whitewashed. It does not need a psychologist to tell us that the amenities of the mine greatly benefit by this simple measure.

There are two obvious objections to the view here propounded. Nystagmus may be present without disability; but the physio-

logical effect of continued emotion (and what we properly call a *neurosis* may perhaps be described in those terms) does not of necessity imply a secondary aim in the way of escape from work or danger. Secondly, it may be said that the nystagmus is of purely physical origin and in its turn produces a psycho-neurosis. It is impossible formally to disprove this hypothesis, though much talent has been vainly spent in the effort to prove it, but I submit that the nystagmus itself presents no characteristics inconsistent with a psycho-neurotic origin, that there exists no reason for separating it from the rest of the syndrome, and that the view here presented accords with our experience of other psycho-neuroses. Yet this introduces such alarming complexities into the situation that we feel urged to seek the simpler alternative of a physical cause. The obvious and continued failure of our efforts in that direction will ultimately compel us to accept the psychological explanation, which covers more of the facts already observed than does any other theory, and is not contradicted by any of them. When that happens we shall only be following the precedent found in the history of "railway spine" and "shell-shock."

CHARLES F. HARFORD

IT is nearly ten years since I carried out a series of careful observations on a group of cases of miners' nystagmus which had found their way into the Army and had relapsed during military training. I have vivid recollections of these cases, the details of which were similar to those described by Dr. Lister Llewellyn, and the memory prompts me to offer a small contribution to this discussion.

For purposes of reference there are appended to this paper a list of the contributions which I have published bearing on this subject. In 1916, I had no experience of modern medical psychology though I described the condition then as "Visual neuroses of Miners."[1] Since then I have referred to miners' nystagmus in a contribution to a discussion on the "Psychology of Vision in Health and Disease."[2] Later, I discussed "Psychopathology in Ophthalmic practice,"[3] indicating the close connection between psychical disturbances and the eye. A year ago I put forward a working hypothesis to explain the effect of the mind upon the body, which may serve as a basis for studying the psychical aspects of disease.[4]

With this introduction I propose in a brief summary to compare the condition commonly known as shell-shock with miners' nystagmus mainly in the light of the report of the War Office Committee of Inquiry into shell-shock, and particularly as to its aetiology.

1. *Its name.*—Dr. Rivers said that the term "shell-shock" has been "a gross and costly misnomer," and there was general agreement among the witnesses on this point. The term "miners' nystagmus" is also seriously misleading, and both of these terms suggest a disability which is liable to be permanent and one that is pensionable in each case with the disastrous consequences which are attached to these ideas.

2. Both of these conditions are mainly *emotional in origin,* and occur in individuals whose personal or family history frequently shows elements of instability.

3. *Trench Warfare and Work in a Mine* have many points in common, viz.:—work in cramped positions, involving great monotony, elements of danger without a ready avenue of escape, injuries to the head, the risk of being buried or of poisoning by noxious gases.

4. *Fear of the dark* is so common as a factor in the production of psychopathic disorders that it deserves special mention. This and the fear of closed spaces such as tunnels, which in civilian life is referred to as claustrophobia, are instances of mind disturbances which are not only associated with shocks and terrifying experiences of the past but also bring back recollection of severity in discipline at the hand of officers, employers, parents or teachers.

5. *Escape from a situation regarded as intolerable* is believed by many to be an explanation of the development of disabilities such as paralyses, tremors, loss of sight, hearing, or speech which may be regarded as comparable to the visual symptoms of miners' nystagmus. The motive which produces these is in the main unconscious but none the less real, and if understood it explains the origin of many obscure maladies.

6. *The spread of shell-shock* as of miners' nystagmus has been compared to the progress of an epidemic, and an "infected pit" is a term which has often been used. The psychology of the crowd readily interprets these manifestations.

7. The importance of "controls" in experimental work is generally recognized and these are ready to hand in both of the conditions we are comparing. Shell-shock cases were a mere fraction of the multitudes of men who were subjected to identical conditions, and it is the same in the mines. Obviously, we must look beyond the factors of illumination, or posture, or refractive errors for the solution of our problem, and shall be driven back to consider more closely the personal element, which is essentially our duty as medical practitioners.

8. *Morale.*—Summing up all the opinions of the witnesses in the shell-shock committee there emerges one idea which can only be expressed by the inimitable word which we have borrowed from the French—"morale."

Medical psychologists with all their differences in matters of technique or detail might be found to agree on some such statement as the following:

(*a*) That emotion is one of the most powerful factors in the causation of disease.

(*b*) That the emotion which is most powerful in the conditions under discussion is "fear."

(*c*) That these emotions are not recognized by most of the sufferers until they have been tested by a wise system of mind treatment.

(*d*) That the inhibition of the desire to get well, which is determined by the lure of a pension, restlessness, discontent and a host of other factors, is the most serious obstacle to recovery.

We are all of us faced by difficulties, which demand courage and patience. We are all tempted to flee from reality and seek some haven of rest from "intolerable" conditions, and to ascribe our ills to our surroundings. Let me conclude by a quotation often used by my friend Dr. Crichton Miller as applied by that incomparable psychologist Sir James Barrie:

> "The fault Dear Brutus is not in our Stars
> But in ourselves that we are underlings."

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THOMAS J. SACK

I AM not an ophthalmologist and wish to take this opportunity of thanking Dr. Levy for according me the privilege of taking part in this discussion. I am speaking on behalf of those engaged in providing the miner with light.

The Miners' Nystagmus Committee, appointed by the Medical Research Council, in their report published in 1922, unanimously reached the conclusion that miners' nystagmus was solely the result of deficient illumination.

Electric lamp manufacturers have been endeavouring to act on this report by producing lamps giving more light, but they have been badly handicapped by the limitations imposed as regards

the maximum weight the miner would agree to carry (5-6 lb.), also by the necessity of making the lamp robust enough to stand the rough and tumble of a mine. These conditions have practically confined designers to a 2-volt accumulator, and unfortunately, 2 volts is the very worst voltage from the bulb makers point of view. Experiments are now being made with a view to producing a 4-volt accumulator that will conform to the requirements just stated. This will enable bulb makers to provide gas-filled or half-watt bulbs, giving about four times the candle power of the 2-volt vacuum bulb.

The introduction of the yellow tinted or Euphos well glass opens up a new aspect of the case, and I should have welcomed some explanation from the eye specialists present as to the physiological explanation of the results obtained by the use of this glass in the Ebbw Vale Colliery. I have heard unfavourable reports from other collieries regarding the use of this glass, but I must confess that I do not believe it has been tried out as carefully anywhere as it has been by the Ebbw Vale Colliery.

Some have tried to explain the effectiveness of this glass by saying that it cuts out the harmful ultra-violet light, but Verhoeff and Bell, and also Luckiesh have shown that only wave-lengths below 3050 Ångström units have a deleterious effect on animal tissues.

Further, lead glass 1.5 mm. thick is opaque to these harmful wave-lengths, and in view of the fact that the bulb is about 1 mm. thick and the well glass about 3 mm. thick there is absolutely no chance of any rays of harmful wave-length reaching the eye of the miner.

But a practical test is the best proof, and I have tried yellow tinted well glasses against clear well glasses in a dark room, and found there was no question but that visibility was materially better when using a Euphos well glass than when using the clear well glass.

The research laboratories of the General Electric Company made tests on the absorption of the light by Euphos well glass, compared with a clear well glass, and were considerably surprised to find that the absorption of the Euphos glass was no greater than that of the clear glass. The only possible explanation of this is that the ordinary clear well glass is of poor quality glass.

I am afraid the claim that Euphos glass is effective because it reduces glare cannot be substantiated. White sprayed or frosted bulbs would be more effective in reducing glare. The oil safety-lamp has been convicted as being more responsible for nystagmus than any other form of illumination, but glare is the last thing of which one could accuse it.

FREDERICK ROBSON

HOME OFFICE RETURNS 1923,

(Published January, 1925.)

COAL MINERS' NYSTAGMUS.

Year.	Old Cases.	New Cases.
1908	74	386
1909	380	631
1910	662	956
1911	1144	1375
1912	1819	1376
1913	2149	2402
1914	3218	2775
No figures available	—	—
	—	—
	—	—
	—	—
1919	3731	2718
1920	4163	2865
1921	4804	1913 (3 months' strike)
1922	5063	4092
1923	7273	3883

INDUSTRIAL DISEASES.

Miners' nystagmus contributed 66 per cent. of the total number of cases. The growth in the number of cases of this disease since 1908, the first full year after the disease was scheduled under the Act, is very striking:

In 1920, 7.2 per 1000 underground men } nystagmus
In 1922, 9.9 „ „ „ }

MEDICAL men during the last 50-60 years have recognized eye defects, and some general nerve disturbances in coal miners, which had not been fully understood. The condition was sometimes called chorea; but in more recent times there has been a nearer approach to its elucidation and definition.

The increased knowledge of coal and its chemistry, produced by the intensive work of the coal chemists, has helped the clinician to visualize the possible chemical relationship of coal to the neurological defects in the miner.

A standard classification of coal is that by Mr. C. A. Seyler, who postulated certain definite carbon to hydrogen ratios in different kinds of coals, separating them into bituminous, carbonaceous, anthracite, lignitous, etc. Further chemical researches have succeeded in distinguishing in the coal mass two main types of compounds, viz.: Cellulosic and resinic, with sub-divisions into groups known as, alpha, beta, and gamma compounds which are found to have different characteristics and capabilities.

The class of coal in which nystagmus prominently arises, is the bituminous coal. In this coal the gamma compound reaches its maximum, viz.: 17/18 C/H ratio. The gamma compound is found least in coals of 23 C/H ratio.

*"The anthracite coals have no gamma compounds. Bituminous coal has a large amount and is capable of greatest resolution by solvent agents.

"Coals with the greater "γ" content are found in Monmouthshire, where the C/H ratio ranges round 17. It is, therefore, in the bituminous portion of the coal field that gamma compounds are chiefly found."

Gamma compounds are resinic and contain *inter alia* hydrocarbons.

The hydrogen content of a coal is one of the chief determining characteristics in its classification, and attains its highest percentage in bituminous coals. The hydrogen in bituminous coals ranges from 5.0 to 5.8 per cent. Volatile matter in bituminous coals ranges from 23.0 to 40.0 per cent.* The coals in the eastern end of this coal field have the highest percentage of hydrogen, and the lowest C/H ratio; and those in the western end of the coal field the least hydrogen and the highest C/H ratio. The coals of highest hydrogen content give rise to the highest percentage of nystagmus. On this basis it is a fair inference to say that the highest incidence of nystagmus is associated with certain compounds in coal. Such compounds are of the gamma class and are to be found in bituminous coals.

Coals of the bituminous type have also the highest proportion of volatile matter, and the writer's original assumption, that the volatile content of a coal was the index of a coal-complex that gave rise to the highest incidence of nystagmus, is found to be that coal associated in chief with gamma compounds.

In consideration of the importance that coal analysis and its behaviour have upon this genesis of nystagmus, I think it advisable to give Dr. Illingworth's evidence *in extenso* so far as the technique of the constitution of coal has been developed chemically:

(*) S. Roy Illingworth, D.Sc. *Vide* Coal Miners' Nystagmus. Robson.

"It is at present possible to detect in the coal conglomerate four types of substances which can be defined as follow:

Ulmin Compounds.—Present in lignitous coals up to 14 C/H ratio.

Alpha Compounds.—Present in all coals, least in lignites and most in anthracites.

Beta Compounds.—Present chiefly in coals of C/H ratio of 14 to 15, which decline westward as the C/H ratio increases.

Gamma Compounds.—Found least in coals of 23 C/H ratio. Reaches its maximum in coals of 17/18 C/H ratio."

For the purposes of this paper it is required to deal with the coals containing the gamma compounds chiefly.

"The gamma compounds are present in the varying amounts in all types of coals, of which the C/H ratio is less than 23.

"The amount is small in lignitous coals, but gradually increases with increasing C/H ratio, reaching a maximum when the value of that ratio is about 17 to 18; with further increase in the value of the C/H ratio the quantity of gamma compounds in the coal decreases until when the ratio exceeds 23 none can be detected.

"Anthracites and sub-carbonaceous coals contain no gamma compounds, the lignitous coals very little, while coals of the bituminous class are characterized by the relatively large amount of "γ" compounds they contain.

"The bituminous coals in general owe their most striking properties to the presence of gamma compounds.

"These compounds are characterized by the relatively high proportion of hydrogen they contain, and the actual quantity is greatest in those gamma compounds that are derived from coals having a low C/H ratio, and it is interesting to note that there is a greater quantity of volatile matter evolved from such "γ" compounds than from those derived from coals of which the C/H ratio is higher.

"In general the amount of gamma compound increases with a C/H ratio up to a value of 17 or 18.

"The anthracite coals are devoid of gamma compounds, and do not yield hydrocarbon by-products.

"The variation in the properties of any one class of coal, as its hydrogen content increases, can in general be ascribed to an increase in the proportion of the "γ" compounds contained in them.

"It is to be remembered that the gamma compounds consist essentially of compounds rich in hydrogen, and that they yield much greater quantities of volatile matter than either the beta or the alpha compounds. This increase in the poor types of coals and the decrease in the quantity of the beta compounds therein cause these coals to be high in volatiles.

Coals with the greater "γ" content are found in Monmouthshire where the C/H ratio ranges round 17. It is, therefore, in this bituminous portion of the coal field that gamma compounds are chiefly found."

These compounds contain a high percentage of hydrogen, and a high percentage of hydrogen is in some generic relationship to that of miners' nystagmus. It may be true, therefore, that nystagmus is not independent of "γ" compounds found in coal, This type of coal is worked in Monmouthshire and declines westward.

Monmouthshire heads the list of the divisions in South Wales for origin of the disease. Dr. Illingworth says: "That carbon monoxide is present as a constituent of occluded gases in high volatile coals.

"That these coals are more susceptible to oxidation and to the production of carbon monoxide (CO). That coals in oxidation give rise to CO, and further, it is the bituminous coals which are more prone to oxidation.

"The production of CO reaches its greatest value in the lignitous coals which are rich in humic substances."

It has been indicated that coal seams traversing the coal field contain compounds peculiar to the coals in each section of the coal field, when measured by their C/H ratios—and that a complete change of type of coal occurs in the total distance of 50 miles east to west—from bituminous to anthracite coal.

A similar change of coal occurs from south to north, and this is well illustrated by the coal changes in about 10 miles from Llanelly to the top of the Gwendraeth Valley, *i.e.*, from a low to a high C/H ratio, and a corresponding decline in hydrogen content, and a correlated decline in nystagmus incidence.

Drs. Strahan and Pollard found that in about 50 per cent. of the pits examined, the coal seams (geologically) proceeded from soft (bituminous) to hard coals, but other pits show a reverse of this order, and in some pits the carbon varies irregularly. And the same results are observed in C/H ratios, therefore, in some pits the upper seams have a higher C/H ratio than those below them, and the more volatile coal is stratigraphically deepest.

The general truth, however, is the lower seams are more anthracitic than those above. There may be a difference of 2 per cent. in C/H ratio in a few hundred feet (see pages 235-6 "Miners' Nystagmus," Robson).

If the softest coal is stratigraphically deepest the influence of increased temperature and pressure gives rise to a high percentage of nystagmus. (Example.—The Bute Seam Colliery Company, H., page 262, "Coal Miners' Nystagmus," Robson.)

The writer considers that nystagmus follows the hydrogen line, and is a measure of such hydrogen change—plus or minus.

The change is also reflected in the volatile content of a coal, and the volatile content is an expression plus or minus of the gamma compound content, and both together are indicative of the kind of coal that can give rise to the highest percentage of CO, and of hydrocarbons.

The fact that coal miners' nystagmus is not general throughout the coal fields of Great Britain, being much more common in some than in others, and more common in some pits than in others, prompts the thought that nystagmus might have some specific connection with a distinct class of coal wrought apart from or in conjunction with coal of the bituminous class, which has been indicated to exhibit "γ" compounds, and correlative nystagmic incidence.

As far as South Wales and Monmouthshire are concerned the pits examined by the writer have clearly shown that the volatile percentage in the coal has in many instances been the "touch-stone" or criterion of nystagmus incidence. In those pits where most cases arose at greatest depth, the influences of increased pressure and highest temperature on harder coal also gave rise to much nystagmus—when estimated upon the number of men employed in the seam.

Spontaneous Combustion of Coal

"Spontaneous combustion in coal mines is a phenomenon which may be defined as the heating of coal by means, other than the artificial application of heat."

Probably all bituminous coal is liable to spontaneous combustion in some degree, and this liability to self-heating varies in the coal fields of the United Kingdom, and speaking generally, the thicker the seam the greater the liability to spontaneous combustion. "That the proportion of volatile matter yielded in coal plays an important part in the sensitiveness to inflammation."(1)

Specific heat of Coal in relation to its Composition

"The specific heat of coal lies in general, between 0.2 and 0.4 depending upon the amount of water contained in the coal.

Increase in C/H ratio causes a decrease in specific heat, and in general with increase in volatile matter there is a corresponding rise in specific heat." (2)

(1) Prof. Bedson.—*Trans. of Inst. of Mining Engineers*. Vol. XXXIX, p. 724, 1909-10.

(2) G. Coles, B.Sc.—*Colliery Guardian*, November 23, 1923.

A study of the factors concerned in the spontaneous combustion of coal, together with the evidence of the Commission on the same subject, gives some indication of the complex nature of coal, and its gaseous possibilities under varying degrees of pit temperatures and pressures, as indicated by the stratigraphical position of the seams, and also the influence of such adventitious bodies as iron pyrites in the process of spontaneous heating.

The fact that spontaneous heating is not general, but particular throughout these coal fields, suggests that the origin of nystagmus might have some specific relation to a distinct kind of coal won, and the geological and working conditions appertaining to such pits in which spontaneous heating arises. The following conditions play an important part in spontaneous combustion, and many of these conditions are to be associated with a coal that gives rise to nystagmus:

1. Roof conditions.
2. Inclination of seams.
3. Depth of seams from surface.
4. Thickness of seams.
5. Amount of cover.
6. Depth below datum line (sea level).
7. Temperature of mine air.
8. Temperature of coal faces.
9. Friability of coal.
10. Moisture content of coal.
11. Class or type of coal.
12. Oxidizability of coal, or the O_2 content.

Dr. Wheeler says: "Self-heating of coal is determined by the oxygen content, the higher the oxygen content the more readily will coal self-ignite—by oxygen content is meant not oxygen in coal as gas oxygen but oxygen present in coal in combination with other bodies forming chemical compounds not definitely known. If coals be analyzed to find their ultimate constituents, *i.e.*, C.H.O.N. and S it will be found that oxygen in different coals varies between 1 per cent. by weight in anthracite coal to 17-20 per cent. in bituminous and lignitous coals.

"This high oxygen content gives a low temperature at which ignition takes place. This refers to chemical composition of coals apart from iron pyrites, which are adventitious bodies. When freshly cut coal is exposed to air or oxygen at atmospheric temperature a considerable volume of oxygen is absorbed and sometimes CO and CO_2 are produced, according to the nature of coal, but not in all coals."

It is not inconceivable that nystagmus arising in some parts of these coal fields, may be connected with that type of coal which

is capable of self-heating, *sui generis*, or by aid of iron pyrites, the initial temperature of such oxidation being the pit temperature. The writer has indicated that nystagmus has a generic relationship to coal of the bituminous class, in chief, and such coal has a definite composition as expressed by the carbon to hydrogen ratio 17-18. As far as Monmouthshire is concerned, this ratio was about 15/17 in the pits in which most cases of nystagmus arose.

It is said that the moisture content of coal has an influence upon its oxidation, thus moist coal oxidizes more readily than dry coal, moist coal absorbs oxygen 50 per cent. faster than dry coal (moist is used in its chemical not physical sense). An example of the difference in moisture content and heating of coal is that of the Durham coal, which is extremely low in moisture content.

On the other hand, some of the coals in South Staffordshire are very high in moisture content, and spontaneous combustion is said to be possibly the highest in the world.

In the Durham coal field there has been no well authenticated case of spontaneous heating for 200 years, since the time of Queen Anne. The percentage ratio of nystagmus based upon total men is low, viz., in 1920, 0.15 per cent. The Northumberland coal field has some slight history of spontaneous combustion above that of Durham, and the cases of nystagmus in 1920 were 0.21 per cent.

It is suggested that: "The freedom from fires in Durham and Northumberland is possibly due to the low oxygen absorption of these coals. It is less than 300 c.c. per gramme at 30°C."[3]

The anthracite mines of South Wales do not give rise to spontaneous combustion. Its coal has no gamma compounds, and the incidence of nystagmus is only about one-fourth of that found in Monmouthshire.

The anthracites have small capacity for oxygen, and the hard steam coals have a low oxygen capacity at 33°C.

On the other hand, the Barnsley coals (Yorks.) having absorption of 300-500 c.c. per 100 grammes at 30°C., are all liable to fire.

	1909	1914	1919	Nystagmus %
Durham...	0.034	0.21	0.20	
Northumberland ...	0.04	0.13	0.21	
Staffordshire South ...	0.44	0.56	0.75	

There is no liability to spontaneous combustion in the Kent coal fields; four cases of nystagmus have arisen in this field, viz.:

2 at Dover	In 1923 and 1924
1 at Canterbury	
1 at Deal	

(3) Stopes and Wheeler.—Spontaneous Combustion of Coal, p. 99

Mr. Ivan Graham,[4] speaking of this field in relation to the return air samples in various pits in this country showed that there was no spontaneous combustion in the Kent coal, and that in the average of three tests made for air O_2 absorbed, viz., 0.17 per cent., there was produced 0.0011 per cent of CO. In one case in the return 100 yards back from the face (200 yards of face) 0.10 of O_2 absorbed gave rise to 0.0004 per cent of CO.

Spontaneous combustion in Scotland is rare except in the district of Fifeshire. In the Kent coal field depths range from 1-2,000 feet, volatile matter 10.0 to 30.0 per cent., sulphur 0.50 to 1.0 per cent. There is a decrease of volatile matter with depth throughout the Kent coal field.

The coal fields of Yorkshire and Staffordshire have frequent attacks of spontaneous heating, and with coals capable of this activity I associate some at least of the cases of nystagmus. As far as Yorkshire is concerned, the large number of men attacked appears to the writer to be due to some disseminated cause, such as toxins from mine gases.

Professor Briggs, in a communication to the writer, said that, from information received, certain coals in the Maitland coal field of New South Wales oxidized rapidly, and the coal became hot before it could be removed from the mine, indicating rapid oxidation of this coal. The men suffered badly from pink eye and nystagmus in one and the same man, and had to be led about the pit. After an absence from the pit for purposes of recovery, the condition recurred in men resuming underground work.

"The reaction between oxygen and coal that results in the fixation of the oxygen is accompanied by a heating effect, so that . . . . if the dissipation of the heat is prevented the temperature of the coal rises. . . . Spontaneous fires may occur in coal in the mine, or on the surface, and thus it is that several factors, other than the chemical constitution of the coal, have to be considered.

"On the chemical constitution of the coal the rate of its reaction with oxygen at a given temperature mainly depends, but its state of division, permeability, and physical condition generally, also affect this rate of reaction; whilst the rate of dissipation of heat is governed by such factors as the amount of ventilation and the thermal conductivity of the coal itself and of its surroundings."[5]

It would appear that the harder the coal the more oxygen is required to produce spontaneous combustion, if any, and the reverse of this obtains.

The Pumpquart Seam—a hard anthracite coal in South Wales—is not liable to spontaneous combustion, for 0.50 per cent. of oxygen absorbed gave rise to 0.0016 per cent. of CO, on the

(4) *Colliery Guardian*, October 10, 1924.
(5) Wheeler—*Fuel*, p. 14, Bulletin No. 1.

analysis of the return air sample—nystagmus is lowest in anthracite coals.

In contrast with this seam, in the Victoria seam—a house coal—capable of giving rise to spontaneous combustion, a large amount of pyritic oxidation is possible, for with 0.20 per cent. of oxygen absorbed, there resulted 0.0028 per cent. of CO., and nystagmus was 0.48 per cent. based on the number of men employed.

IVAN GRAHAM, M.A., M.Sc.

1. "That any form of pyrites in a finely divided condition will absorb oxygen rapidly from the air with consequent heat production.

2. "That in many cases of spontaneous combustion underground, pyrites must be looked upon as the primary cause of the trouble.

3. "That heatings due to oxidation of pyrites will probably develop more rapidly than those caused by the oxidation of coal.

"At the same time if it were possible to take a census of all underground heatings and ascertain the primary cause of each, the majority would, I believe, be traced to the oxidation of the carbonaceous constituents of the coal."(1)

In one of the South Wales pits, spontaneous heating and fires arose in the 9 foot seam. There was much disseminated amorphous pyrites present in the seam (manager). This seam was worked at a depth of 1,737 feet, and had a volatile content of 11.54. It was, therefore, a hard coal of the steam coal variety. Nystagmus cases were 14, and 12 of these arose at the coal face.

"Various researches in the oxidation of coals from different seams throughout the country have shown that:

1. "Coals like anthracite and Welsh steam coals which have a small capacity for absorption are not likely to fire.

2. Some coals which show a low rate of oxidation at ordinary temperature may fire when mixed with pyritic material.

3. "Coals which show a large rate of oxidation which increases with rise of temperature may give rise to spontaneous fires. Many bituminous coals are included in the latter class.

"The heat production during oxidation of coal at 40°C (soft coal) and 55°C (hard coal) was found in each case to equal 2.1 calories per c.c. O_2 absorbed."(1)

This paper so far indicates that bituminous coal, which is friable, contains moisture, oxidizes rapidly at normal temperatures, with and without the presence of pyrites, may give rise to spontaneous heating.

(1) *The Colliery Guardian*, March 24, 1924.

It was shown by Mr. Graham, who examined the Victoria seam in South Wales, that the carbonaceous material absorbed only a very small quantity of oxygen compared with that absorbed by coal from the Barnsley Seam (Yorks), a seam very liable to spontaneous combustion. The results indicated that in the main the source of heating was due to pyritic material.

This is to show that soft coal poor in carbonaceous material, may require the presence of some auxiliary material like iron pyrites to cause it to inflame.

A sample of air taken from the neighbourhood of a heating in this pit shows the presence of 0.013 of CO for 0.28 per cent. of oxygen absorbed; that indicates a small production of CO.

A similar heating in the Barnsley Seam would probably have shown five times the amount of CO for the same O_2 absorption.

"During the oxidation of pyrites, carbon monoxide is not produced.

"The composition of Black Damp, resulting from pyritic oxidation, may vary considerably as regards CO_2 content from a few per cent. up to 12 per cent.

"In the instance quoted (Victoria Seam) the low production of CO is probably to be explained by: (1) Oxidation of pyrites; and (2) the fact that carbonaceous material undergoing oxidation produces a smaller amount of CO for a definite absorption than is the case with Barnsley Seam, and many other similar coals."

(The Barnsley Seam is very liable to spontaneous combustion, *sui generis, i.e.*, without the aid of the adventitious body, iron pyrites.)

One test of the return air illustrates the effect of the pit being idle—fan slowed down. The oxygen deficiency was 1.40 per cent. and the carbon monoxide formed was 0.0034 per cent.

The effect of the installation of new fans in pits in South Wales was considerably to reduce the incidence of nystagmus—indicating better ventilation.

The Yorkshire pits show a high incidence of nystagmus, based on man power, and higher than South Wales and Monmouthshire combined.

"It is estimated from an examination of one pit in Yorkshire, that 25 to 38 per cent. of the men (according to the grade of men employed) were working with nystagmus. On this basis it is reckoned that 25,000 miners are working with oscillation of the eyeballs in Yorkshire. These men do not know there is anything wrong with them, *i.e.*, there is no disability. The report says the oscillation when not accompanied by subjective sensations is of negligible consequence."

The present writer suggests from the foregoing evidence that certain seams in Yorkshire are very provocative of the trouble,

and those seams are probably subject to spontaneous combustion, or liable to self heat, normally or by aid of iron pyrites such seams are of the soft coal variety or bituminous class with a high oxygen absorptive power and with formation of much carbon monoxide.

I have no knowledge of the analysis of the coal from the gamma compound content standpoint.

In any consideration of the eye and the lids in their abnormal movements as expressed by the terms, nystagmus and blepharospasm "it is necessary to remember that the eye is an item in a Commonwealth and not an isolated entity calling for individual consideration" (Dr. Alex. Wilson). Any study of the origin and cause of the disease in men, different from that primarily of the eye, as an organ of sight, involves the examination of the sites and agencies which might be considered to be detrimental to the underground worker, and which would therefore be considered to be environmental and not personal.

The places of origin of nystagmus are coal pits, but all coal pits do not give rise to the disease, therefore, there is some agent present in some pits that is absent in other pits, and in those which do give rise to nystagmus there are fundamental factors to be considered, common to all deep pits, whenever locked safety-lamps are used. Open lights are used in other shallow pits.

No metalliferous mines, however deep and therefore dark, give rise to the disease, with the exception of some iron-stone mines "where on account of the presence of thin coal seams, and where, therefore, safety-lamps are used, nystagmus is found."[1]

The American and South African coal mines do not give rise to nystagmus. They are for the most part shallow mines, and enjoy good ventilation. I have already referred to the New South Wales mines, where rapid oxidation of the coal arises, and much and aggravated nystagmus occurs.

It is found that all grades of underground workers in this country contract the disease, but chiefly the collier, and, therefore, at the coal faces.

The incidence, however, arises in different ratios to man power, in different seams, and the same seam in different pits, may and does give rise to varying percentages. And this same seam of coal, a few miles further west towards anthracitation, gives quite another set of figures, a reduced incidence.

The absence of uniformity in the different pits suggests:

1. Either that the coal differs in some particular way; or
2. That pit details vary.
3. That age of pits is dissimilar.
4. That man himself varies in some particular way, possibly in his blood content.

(1) First Report of Miners' Nystagmus Committee, p. 10, 1922.

In addition to these details we have to consider depth; datum line (sea level) or cover; class of coal; volatile content; presence or absence of iron pyrites; moisture content; friability and oxidizability of the coal wrought.

There are over 600 pits in South Wales and Monmouthshire. About 63 per cent. of these are represented in the Indemnity Society of South Wales and Monmouthshire, and the divisions of this territory divide the coal, for statistical purposes into Monmouthshire, Glamorgan East (Rhondda), and South Wales West. The coal seams, however, do not correspond exactly to these divisions in their topography, yet the statistics of the coal owners are sufficiently accurate to warrant the field being divided roughly into bituminous—hard steam and anthracite areas.

Electric hand lamps were introduced into the coal field in 1914, and since that date there has been a steady increase in their adoption and use. Nystagmus rate has, however, not been influenced by such installations of lamps, since the evidence of figures already produced in previous papers ("Miners' Nystagmus," Robson) shows no decline. In South Wales the numbers for 1923 were:

Lamps	
Oil flame lamp	112,153
Electric safety	107,804
	219,957

In dealing with miners' nystagmus, therefore, we have three chief factors to consider:

1. That lamps have a common denominator measured in candle power to all the proportions put forward.
2. That coal, unlike lamps, has no fixed common denominator value, inasmuch as its constitution varies morphologically in each area, but not strictly so, and also in each pit, yet may vary in the stratigraphical sequence of its seams.
3. That man himself, as assessed by his blood complex, may be not the least difficult of the three factors concerned in estimating the contributory percentage proportion to the origin of the disease.

Speaking of incipient heatings in coal mines and the analyses of mine air before the coal is suspect, Mr. Graham says:

"There is no doubt we require further knowledge concerning the gaseous oxidation products formed underground both at normal and at elevated temperatures.

"Researches into the cause of spontaneous combustion have thrown a considerable amount of light upon the nature of oxidation which coal undergoes at normal and slightly elevated temperatures,

and other changes which take place in the composition of the air in contact with coal undergoing oxidation. The true nature of these reactions is not yet known and the substances actually responsible for the absorption of oxygen have not been isolated."

I would refer the reader to Dr. Wheeler's experiments on coals of the Hamstead Colliery "slips" and "Brazils," as set out in pp. 9, 10, 11 and 12 of "Fuel, in Science and Practice," Bulletin No. 1. "The Spontaneous Combustion of Coal," by Marie C. Stopes, D.Sc., Ph.D., etc. and R. V. Wheeler, D.Sc.

This publication clearly indicates that CO is produced from coals, after they have been exhausted of the naturally occluded gases: "At 100°C such coals contain a high proportion of oxides of carbon if the coal has been previously weathered either naturally or artificially, thus differing from the gases withdrawn from newly won coal, which consist mainly of metharine and the higher members of the paraffin series of hydrocarbons."

From the researches of the writer into all the coal fields of Great Britain in general, and into that of South Wales and Monmouthshire in particular, the following conclusions are arrived at:

1. That all coals do not give rise to nystagmus.
2. That coals of the bituminous order give rise to more cases than hard steam coals, and much more than anthracite coals.
3. That coals that are capable of self-heating give rise to varying percentages of carbon monoxide according to the amount of oxygen absorbed, and, therefore, to the chemical composition of the coal, as well as to its physical state as regards moisture content and friability and pyritic content.
4. Coals that are capable of spontaneous combustion are found in Yorkshire and Staffordshire chiefly, and to a less extent in other counties, and much nystagmus is associated with such coals.
5. The Kent coal field is practically devoid of nystagmus, and its CO content is almost nil, four cases of nystagmus having arisen in that field in 1923-24.
6. That a high volatile percentage in a coal of the bituminous class with a C/H ratio of 17/18 indicates a coal that contains gamma compounds, and these compounds also are indications of the highest hydrocarbon content.
7. The detailed evidence of pits in South Wales clearly shows that most cases arise in soft coal, whatever position in the pit the seams are found, and such coals have a high O_2 content, a high hydrogen content, and much volatile matter, and a low C/H ratio.
8. Old pits are very provocative of the disease.
9. Pits using many explosive cartridges in soft coal give rise to a high incidence.

10. Pits with new ventilation fans, a reduced incidence.

11. Seams above river levels, a low percentage of nystagmus.

12. The same seam (Rhondda No. 2) worked 900 feet depth, marked nystagmus with much general nerve disturbance.

13. Depth of seams has a contributory influence.

14. The writer considers that alleged neurasthenic symptoms are indications of a disturbed nervous system of central origin, equally with those of the eye muscles, from toxins found in the pit, and are not a separate disease.

15. That poor illumination of lamps is not the primary cause, but may be auxiliary, and, therefore, contributory, when the imbalance of the eye muscles has once been started, either by a toxaemia or by anoxaemia due to oxygen want in the central nervous system.

The writer would like to suggest, but with some degree of hesitancy, that there may be two separate agencies involved in the genesis of the ailment.

This surmise has arisen because of the different aspects of the case presented by different coal fields, *e.g.*, Yorkshire gives a high incidence of oscillation of eyeballs, but the sensation or symptom side of the ailment is made little of, and, if not present, the oscillations, it is said, do not disable the workman underground.

The antithesis of this class of case is the man who is markedly and obviously suffering from some nerve breakdown, called neurasthenia, but who shows very little defect if any in his eyeballs. Such a case suggests to the writer that the cause may be different from that of the man with objective signs only or chiefly; such cases indicate some form of toxaemia, viz., that arising from the presence of hydrocarbons which are to be found in coal that gives rise to gamma compounds in chief, and these coals, as previously indicated, belong to the bituminous class.

The involuntary oscillation of the eyeballs, the writer suggests, is due to the action of carbon monoxide giving rise to the inhibition of the efferent stimuli from the 3, 4 and 6 N. nuclei, or their synapses.

The neurasthenic side of the picture being due to the action of toxic hydrocarbons—affecting the nutrition of the neurones—or the synapses in the higher levels of the central nervous system, *i.e.*, the conditioned area of the cerebral region, as evidence of such surmise. The Rhondda No. 2 Seam is a class of coal that gives rise to a great deal of suffering. It is worked in this instance at 900 feet below the surface, and the cases exhibit in a marked way not only oscillation of the eyeballs, but a general nerve disturbance that is accompanied by much depression and doubts of ultimate recovery.

PROFESSOR COLLIS

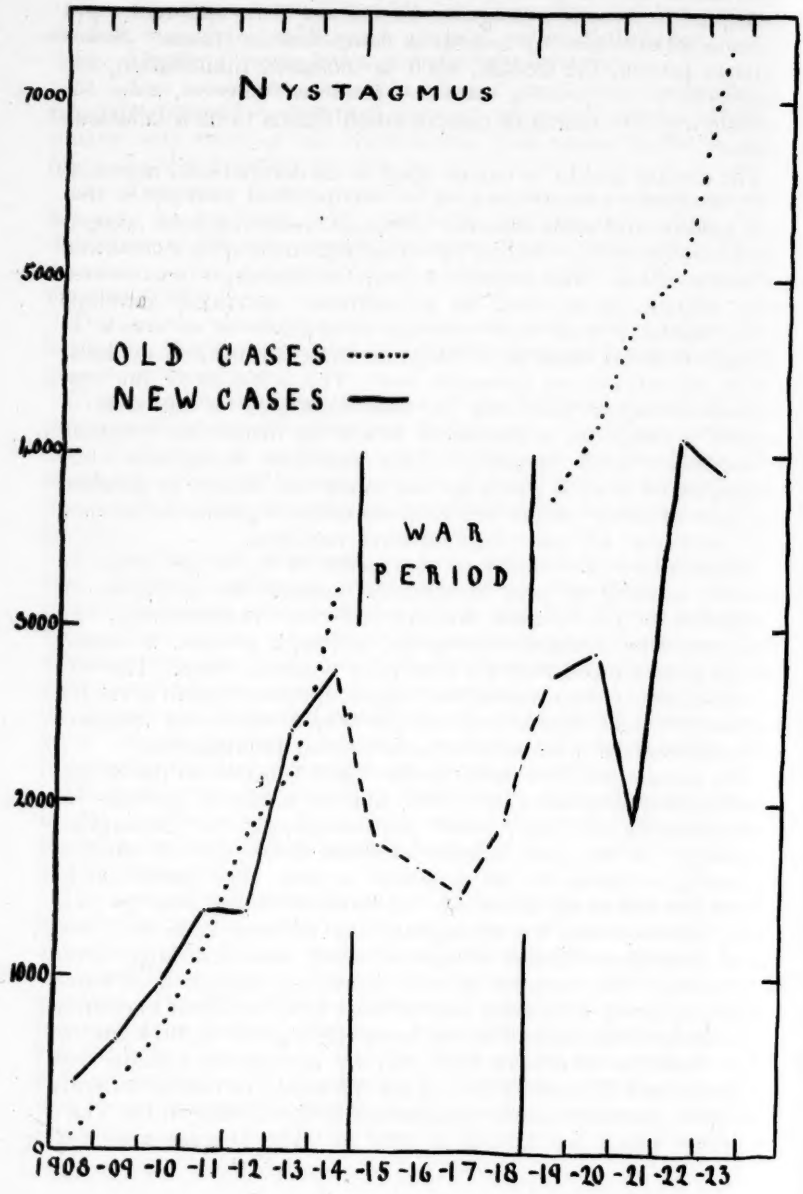
PROFESSOR COLLIS pointed out that much attention has recently been paid to miners' nystagmus on account of its apparent rapid increase as exhibited by records of compensation claims. Hence steps to prevent the disease, such as increased illumination, are suggested to be proving useless. Reasons, however, exist for considering the records of compensation claims to be a fallacious index.

The disease should be looked upon as an occupational neurosis. The distinctive characteristic of an occupational neurosis is that it is named after some manifest symptom, resulting from occupational environment, which symptom is implanted upon a condition of neurasthenia. The distinctive symptom, although in existence, may remain latent until the neurasthenic condition develops either suddenly from such cause as an accident or an attack of illness, or slowly from such things as septic absorption, domestic worry, alcoholism, or economic fear. The influence of the last-named—economic fear—can be well illustrated in the case of miners' nystagmus, a disease of which the distinctive symptom is oscillation of the eyeballs. This oscillation disappears when underground work is given up and traces can seldom be detected six months later; but the neurasthenia tends to persist for months and years after all eye symptoms have vanished.

Examination has disclosed that some 20 to 30 per cent. of miners working in poor illumination possess this symptom of oscillation of the eyeballs without suffering inconvenience. In these men the distinctive symptom, although present, is latent; but its presence constitutes a reserve of potential cases. The way in which, due to occupational environment, this symptom develops, has not yet been determined, but the way in which the influence of compensation may make it manifest can be displayed.

The disease was first added to the Third Schedule of the Workmen's Compensation Act, 1906, and so made a ground for Compensation in 1907, under the designation of Nystagmus (Mining). A few years always intervene before the full effect of including a disease in the Schedule is seen; this course can be traced by following the steady increase of claims year by year from 1908 not only for nystagmus, but for beat knee and beat hand, two other diseases of miners, which were scheduled at the same time. The number of new claims for nystagmus is found steadying about 1911-1912, and for beat hand and beat knee from 1911-1914. The claims for beat knee fell slightly in 1914 and for beat hand in 1913 and 1914; but for nystagmus a sharp rise occurred in 1913 and 1914. This difference is nearly certainly due to an alteration in the designation of the disease in the Third Schedule which was altered in 1913 to "The Disease known as

COMPENSATION CLAIMS FOR NEW AND OLD CASES OF MINERS' NYSTAGMUS



Miners' Nystagmus whether the symptoms of oscillation of the eyeballs be present or not." Clearly this alteration grants compensation for neurasthenia even though the distinctive symptom is absent.

During the war no further increase in claims seems to have occurred, but the records for these years are not official and only refer to new claims. After the war, in 1919, the number of new claims for each disease is found at about the same level as before the war. Next a dip occurs for the strike year, 1921; then comes a sharp rise in 1922.

A great difference is found if, instead of new claims, the number of old ones, *i.e.*, claims continuing on compensation from the previous year, is noted. These old claims for beat knee and beat hand soon reach a steady level; these two diseases are not occupational neuroses, but result from local septic infection. In the case of nystagmus on the other hand, the relation of old claims to new is found growing until there are more old than new claims and the number increases year by year. There can be little doubt that the altered designation of 1913 has much to do with this state of things; it is clearly shown by the rise in old claims in 1914.

Attention must be directed to differences between the provisions of our Compensation Act and those which prevail in Belgium, where the disease also occurs in the Province of Liège. With us compensation lasts as long as incapacity can be proved; in Belgium it ceases at the end of six months. The periods off work for the disease are in accord. For Belgium the figures were:

Period off Work	Percentage
0 to 1 month	28
1 month to 3 months	50
3 months to 6 months	20
6 months and over	2
	100

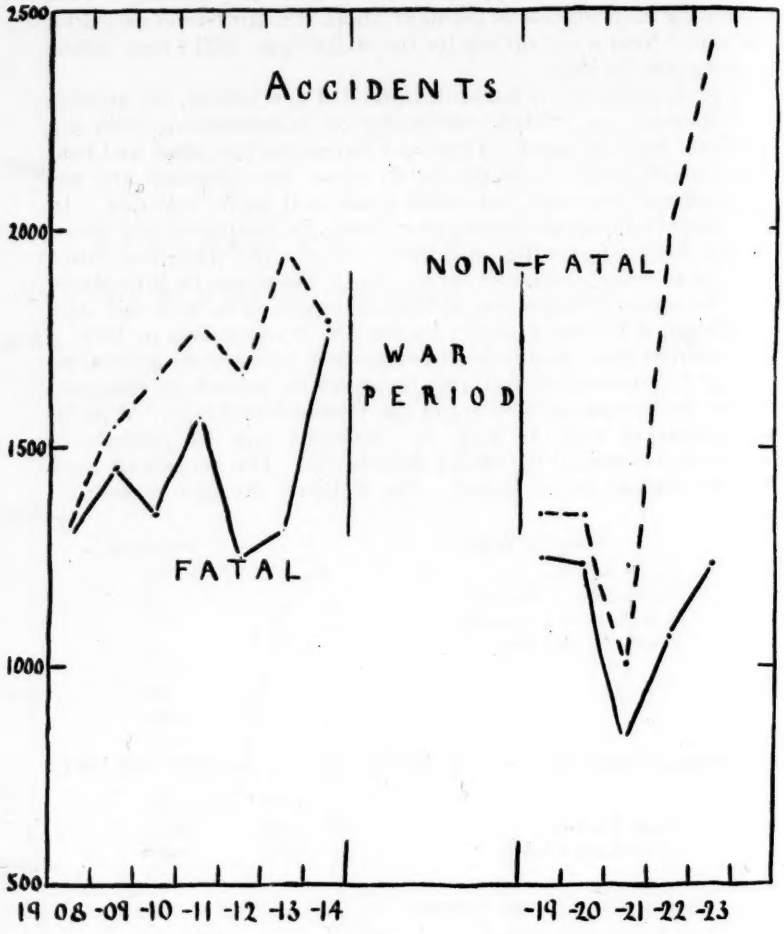
Compare these figures with British records for 1920 and 1921:

	1920	1921
New Claims	2865	1913
Continued Claims	4163	4804

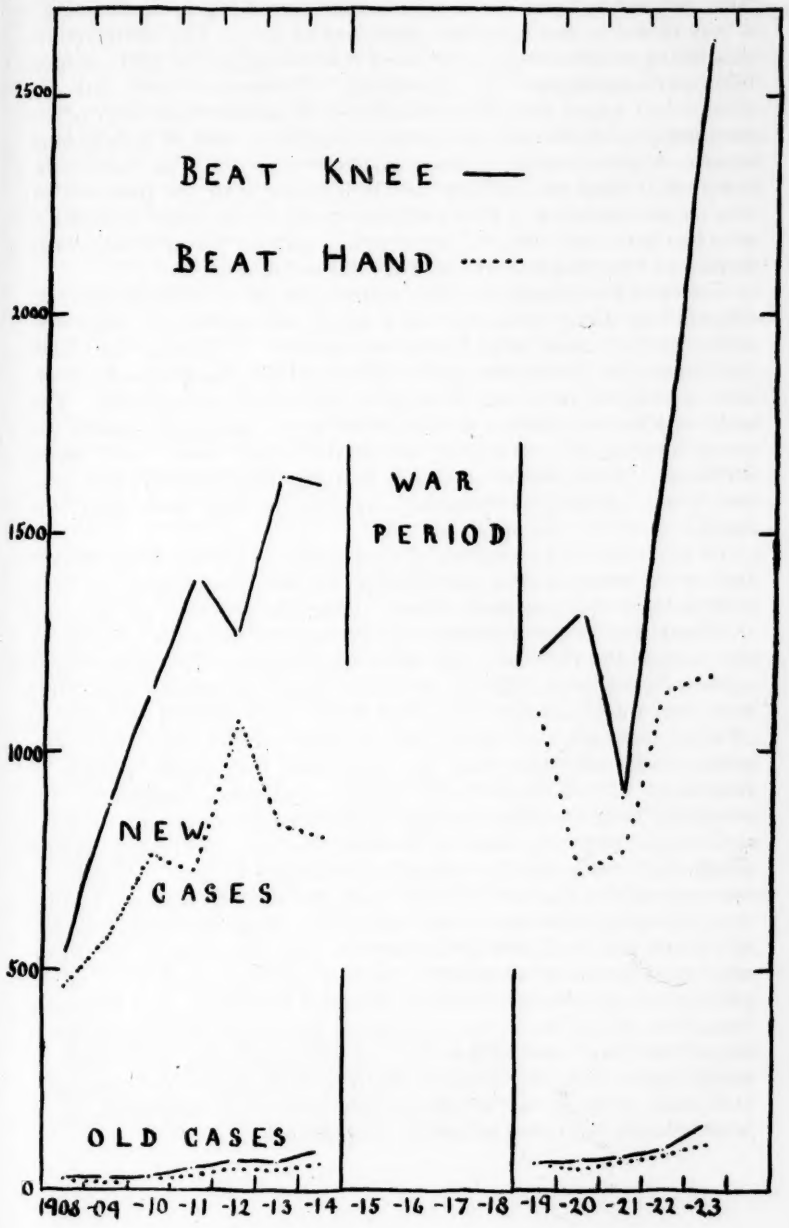
UNTERMINATED CLAIMS LASTING—				
Over 1 year and under 2 ...	952	2382	1363	3465
„ 2 years and under 5 ...	932		1457	
„ 5 „ „ 10 ...	442		556	
„ 10 „ „ — ...	56		89	

COMPENSATION CLAIMS IN THE MINING AND QUARRYING INDUSTRIES FOR FATAL AND NON-FATAL ACCIDENTS

(The scale used for Fatal Accidents is 100 times that for Non-Fatal)



COMPENSATION CLAIMS FOR NEW AND OLD CASES OF MINERS' BEAT KNEE AND BEAT HAND



Even more interesting evidence of economic fear exists. Wages rose and the value of money fell at the end of the war; the sum, 20/-, originally fixed for compensation became quite inadequate; it was raised to and has since remained at 35/-. The influence of this change became apparent when trade slumped in 1921; wages fell and unemployment prevailed. Economic fear due to diminished wages and the possibility of dismissal came into play; neurasthenia developed and made manifest a crop of nystagmus cases. A direct incentive also existed to claim 35/- as compensation rather than to work for but little more with the prospect of loss of employment. This influence is to be seen in the sudden rise in claims not only for nystagmus, but for the diseases, beat knee and beat hand, and for non-fatal accidents.

The accident claims in this matter are of particular interest. Claims for fatal accidents are clearly not subject to economic influences; "stone dead knows no fellow." Claims for fatal accidents were below average in 1922 and 1923, but claims for non-fatal accidents increased in number out of all proportion. The only conclusion possible is that, while there were more claims for compensation for non-fatal accidents, there were not more accidents. Little doubt can exist that this conclusion is also true for claims for the three diseases, nystagmus, beat knee, and beat hand.

In the case of nystagmus the importance of the neurasthenic influence, brought into prominence by the designation in the Schedule of 1913, is easily seen. Whereas previous to then the tendency was for the number of old cases and new cases to be about the same, by 1914 the old cases had become decidedly more numerous until in 1922 out of 9,155 claims (5,063 old and 4,092 new) on the books, no less than 7,273 were carried forward to 1923 as old cases, *i.e.*, only 1,882 claims, or 20 per cent. had been terminated. At this rate no less than five years would be necessary to terminate these claims of disease, incapacity for which in Belgium does not last more than six months.

Enough has been said to indicate the care necessary before accepting compensation claims as evidence of any increase or decrease of the disease. The utmost the records indicate is that miners' nystagmus does exist, and that, when the economic life of the mining industry is unhealthy, the psychology of those employed becomes unhealthy; then a certain number of latent cases from the potential reserve becomes manifest. Far the most important matter is the ever increasing number of old claims based on neurasthenic symptoms with no accompanying oscillation of the eyeballs. The only hope for them is treatment for neurasthenia. It is not nystagmus, which readily reacts to treatment, it is neurasthenia which is of urgent importance.

G. H. POOLEY

MR. G. H. POOLEY said it had been his intention to read a paper, but after the speeches already delivered, it would mean too much repetition.

He had been asked to speak on the personal factor in relation to this subject. This was of two kinds: the personal factor in the observer, and that in the person observed.

The first of these came in to a very decided extent. Some men formed in their minds a theory, and then set out in search of facts with which to support it. Others, the more philosophical, searched dispassionately for facts, and then evolved a theory which the facts seemed to warrant . The latter had not been led away by the fallacy that the number of successful claims for compensation on account of the disease was an index of the rate of incidence of the actual disease. This could only be determined by an examination of all the men working in a particular mine, and, as far as possible, under the actual conditions in which they were working, and then seeing what percentage of them were subjects of the disease, and seeing to what degree they had it. The results obtained in different collieries should then be compared.

It was necessary for him to test the various conditions which were said to cause the disease. Among other things, he was now engaged in testing vision in very very dim illumination; he was trying to find what the normal eye could see, and so far he found that with an illumination of 0.00006 of a candle power the normal eye could still detect colour, and had a visual acuity of 1/72nd of the normal. There was a relative central scotoma, and the object looked at rapidly became dim, but at 5 degrees on the temporal side of the spot looked at there was a point at which the visual acuity was greater than at the point of fixation. With both eyes open there was visual acuity on each side of the point of fixation. The visual acuity was better when using two eyes than when using one in such dim light. There was much flickering and much fatigue, and a moving object was more readily detected than was a stationary one. The colours which could be seen under these circumstances were red, green, which could be seen less readily than red, blue and yellow still less readily. The colours were better distinguished by contrast than by seeing them separately when stationary. The eye was soon fatigued by a dim light, and it maintained its fixation so badly, that there was a tendency, even in the normal healthy eye, to oscillate under conditions of working in a very dim light.

With regard to the personal factor in the man, many men could do their work in spite of having a marked degree of oscillation of the eyeballs. Men whose eyes were never still, even when they looked strongly downwards, still worked regularly at the coal face,

and could even play cricket in quite good teams. Men whose sight was very defective because of cataract and who also had marked oscillation still went on getting coal at the coal face, and some of them declared they would not join the compensation group, but intended to continue working until they were operated upon for their cataract. Recently he saw a man with primary optic atrophy in both eyes, whose visual acuity was 1/60, and though he had to place his hand on the shoulder of another man to find his way on to the cage to descend the mine, he went regularly to the coal face, and earned ordinary wages at it.

Why did men give up? Among the million men engaged in coal-getting, as in any other million men, there were many whose general health was failing and who for other reasons wished to give up work, and those men were particularly liable, when they had nystagmus, to claim compensation for it, because they got more money, and for a longer time in this way than under the National Health Insurance Act. There is among all workers, a definite percentage who are disinclined to work, particularly those having the old-fashioned *maladie imaginaire* described by Molière. He thought this was the condition which existed in many cases of so-called neurasthenia, which commenced some time after underground work had been stopped. The remedy for it was a return to regular work of some kind.

ANNOTATION

Visual Hallucinations

Visual hallucinations in sane people was the title of an interesting communication by Mr. Ormond read at the last Annual Meeting of the British Medical Association in which he gave instructive details of some patients of his own. Francis Galton in his "Inquiries into Human Faculty" devoted considerable attention to the nature of this phenomenon, and proved that a large number of persons were "visualizers." That is to say, that when they memorize an event they see it. Ormond considers that the sensitization of the visual memory area is in these cases abnormally high, just as in the word-blind it is abnormally low. Of all the senses sight is the one in which we have most confidence, yet even here, the final interpretation of the visual impressions conveyed from the eye as an optical instrument depends entirely on the functional activity of the visual cortex. It can never be proved that the same object produces precisely the same sensation in any two observers,

and, as is constantly being proved in our courts of law, two honest independent witnesses will carry away quite different impressions of the same scene. If this is true even immediately, how much greater must the difference be at a later period, when the varying nature of the visual memory is taken into account? As was well said by this year's Bowman Lecturer: "Increased knowledge of the psychology of perception, in which in man vision plays a predominant part, must depend on increased knowledge of the physiology of the special senses. And, further, that the advance of ophthalmology also depends upon increased knowledge of the physiology of the eye and of vision."

ABSTRACTS

I.—MISCELLANEOUS

(1) **Fergus, A. Freeland (Glasgow). — Miners' nystagmus.** *Lancet*, May 23, 1925.

(1) **Fergus**, who, as a medical referee, has had a large experience of miners' nystagmus, comes to the conclusion, in spite of the great amount of work which has been done upon it by such investigators as the late Mr. Simeon Snell, Mr. Llewellyn and Mr. Robson, that the theory of its aetiology, which attributes the disease to deficient illumination, constrained posture, and inhalation of gases is difficult of acceptation, or, as Fergus says, "the verdict must be one of not proven." In support of the contention that we do not yet understand the aetiology of the disease quite the most important point brought out by Fergus is, in the reviewer's opinion, that miners' nystagmus is almost unknown in America. American literature deals with European, not American, nystagmus. Hoffmann, dealing with an investigation in Illinois, states that five hundred miners working under conditions which would render them liable to nystagmus in this country were carefully examined and not a single case of miners' nystagmus found. Hoffmann says:—"No reasons suggest themselves, however, why this peculiar affliction should be limited to mining districts of European countries and not be found in American coal-mining districts, where, on account of the gaseous nature of the mines, the use of safety lamps is compulsory." Again, from his own experience in the Glasgow Eye Infirmary, Fergus recalls that in his early days miners' nystagmus was but rarely seen. This, one may suggest, is not such a strong point as the one previously given from America, for it will be admitted that if

compensation has not increased the incidence it has certainly increased the number of cases seen. In addition to the usual accompaniments of vertigo, tremors, photophobia and night-blindness, Fergus has noted actual diminution of visual acuteness (which he attributes to a central defect and not merely to the oscillatory movements of the eyeballs), and marked disturbances of the circulation. The diminution of visual acuteness, the disturbances of the circulation, and the paroxysmal nature of the attacks lead the author to say that the disease is not purely ocular in origin, and that it is a much more general condition affecting a large number of centres. Because of this wide-spread involvement of nerve centres a possible explanation seemed to be the presence of some micro-organism not hitherto discovered. The author therefore wrote to the Minister of Mines enquiring whether any investigations had been carried out in this direction, and received a reply in the negative. "I must say," writes Fergus, "considering the immense importance of the disease, I think it is high time that such investigations were made. The disease, so far as I know, is never fatal, but still post-mortem investigations might be made on persons who during life were known to have had it, and also there is no reason why, during the attacks, the condition of the cerebro-spinal fluid and of the blood should not be made the subject of investigation." Fergus then deals with the treatment (one might perhaps rather say the management) of the disease and the legal aspects, notably the question of unfitness for work, in a manner which betokens great sympathy with the sufferer from this affection. Readers who are in close touch with cases of miners' nystagmus would do well to study Fergus's article for themselves. Whether one agrees wholly with it or not, it bears the stamp of large experience and much thinking.

ERNEST THOMSON.

(2) **Lo Cascio, G. (Rome).—The light-sense in the periphery of the human retina. (*Il senso luminoso nelle parti periferiche della retina nell'occhio umano.*)** ***Ann. di Ottal. e Clin. Ocul.*, June-July, 1924.**

(2) La Cascio reviews the writings of other workers on this subject, beginning with the observation of Arago that stars of low magnitude appear brighter when gazed at not quite directly. The review of the literature shows that previous workers have arrived at very diverse conclusions. The author remarks that, as some previous experimenters worked in daylight and others after varying periods of dark adaptation, it is not possible to compare their results. He makes special reference to the work of Schultze and of von Kries, which resulted in the latter formulating the "duplicity theory."

Lo Cascio, in his experiments, used as his source of light Nagel's adaptometer, reducing the illuminated area by means of a diaphragm to 3 cm. (diameter). He arranged the distance from the illuminated area to the nodal point of the subject's eye so that the illuminated disc subtended an angle of 2°. This distance was 85 cm. During the experiments, the source of light remained stationary, and different zones of the retina were examined by moving the fixation point by measured distances on a tangent plane. The observations were made between 10 p.m. and midnight. The subject was first put in a well-lit room for fifteen minutes, and then examined in the dark-room after varying periods of dark adaptation. The author made two sets of observations, one to determine the manner of increase of light-sense after varying periods of dark adaptation, the second to determine the light-sense of different parts of the retina after full dark adaptation.

In the first series of observations, he found that there are two types of dark adaptation, one rapid, the other slow. Two of his graphs illustrate these two types. At a part of the retina in the horizontal plane, 10° temporally from the fovea, the light-sense increased rapidly during the first seven minutes, then less rapidly up to fifteen minutes, after which it remained stationary. At 30° nasally from the fovea, he illustrates the other type, the light-sense increasing slowly and steadily up to thirty minutes, after which it was stationary. He found in none of his experiments any increase in light-sense after thirty-five minutes.

In the second series of observations the subjects were dark adapted for forty minutes. He found important variations in light-sense in different parts of the retina. Following the temporal half of the retina in the horizontal plane he found a small perimacular zone in which the light-sense was lower than that of the macula itself, with its lowest value at 2° from the fixation point, beyond this the light-sense increased until at 8° it was greater than at the macula; it remained at the same level from 20° to 40°, where it fell rapidly to a value lower than that of the macula. In the nasal half of the horizontal plane the retina behaved, up to 6°, in a manner similar to the temporal half. From 6° the light-sense increased until 10°, where it rapidly diminished, to become *nil* from 13° to 19° (the region of the blind-spot), thereafter rising less rapidly to 30° from the fixation point, where its value was higher than that of the macula, and then rapidly fell off again. He found the area of complete blindness slightly greater than that corresponding with the ophthalmoscopic limits of the papilla. The zone of low light-sense surrounding the area of absolute scotoma he found to correspond fairly accurately with the green-blind pericaecal zone. The findings in the vertical plane correspond generally with those in the temporal part of the horizontal plane.

The zone of low light-sense surrounding the macula he calls the "physiological perimacular night-blind zone" (*zona emeralopica perimaculare fisiologica*), and suggests that it may be explained by the greater thickness of the retina in this region. The rapid diminution of light-sense beyond 30° or 40° is not due to the progressive narrowing of the pupillary aperture with increasing obliquity of the light because it occurs so suddenly, but is rather due to the alterations in the structure of the retina in the periphery.

The paper is illustrated by graphs, and gives an extensive bibliography of Continental writers.

ARTHUR GRIFFITH.

(3) **Salvati (Alexandria).—The examination of the aqueous humour in certain internal diseases of the eye.** (**L'examen de l'humeur aqueuse dans certaines affections internes de l'oeil.**) *Ann. d'Ocul.*, Vol. CLXI, p. 698, 1924.

(3) **Salvati** claims that the examination of the aqueous humour is of considerable help in certain cases in the diagnosis between inflammation and neoplasm. The points for investigation are as to whether the albumen content of the aqueous is increased, whether the Wassermann reaction is positive even if the blood reaction is negative, whether there are any cells suggestive of or typical of neoplasm?

Technique. A Pravaz syringe, with a platinum needle is used. It is so designed that, on pressing the piston with the thumb, the needle pierces the cornea and enters the anterior chamber. On releasing the piston, fluid is drawn up into the syringe.

Salvati describes the case of a man, aged forty years, in whom a mass was visible within the eye. The aqueous contained an excess of albumen, had a positive Wassermann reaction and slight lymphocytosis. Specific treatment was adopted and cure resulted with improvement of vision from 7/10 to 10/10. In another case, the cells of glioma of the retina were discovered, and in yet another, pigmented cells of a sarcoma of the choroid.

HUMPHREY NEAME.

(4) **von der Heydt, Robert (Chicago).—Contributions of the slit-lamp to our knowledge of anatomy, diagnosis, pathology, and prognosis of ocular disease.** *Amer. Jl. of Ophthal.*, February, 1925.

(4) **von der Heydt** aims at giving a brief outline of the more important facts disclosed by the slit-lamp. It is not possible in an abstract to give all the observations made by the author. The following, however, though well known to those who use the slit-lamp, serve to show its clinical value. Early diagnosis: (1)

Trachoma by finding the otherwise invisible incipience of pannus at the upper limbus; (2) keratoconus by thickening of the nerve fibres, a change in the endothelial reflex, and the presence of the haemosiderin ring; (3) uveitis, by the presence of cellular elements in the aqueous, fluidity of the vitreous and early posterior polar cataract. Opacities in the lens can be localized exactly, small perforations in the cornea are easily seen, *e.g.*, in a case of suspected traumatic cyst of the iris, and numerous other conditions can be studied in detail. With regard to prognosis: In iridocyclitis a retardation of motility of the elements in the aqueous indicates added exudation, while a reversion to greater fluidity indicates improvement. In senile cataract the presence of lamellar separation or of water clefts indicates a tendency to rapid progression—their absence the reverse. The presence of subcapsular vacuoles in advanced cataract indicates an easy extraction.

F. A. WILLIAMSON-NOBLE.

(5) **Yudkin, Arthur N. (New Haven).—An experimental study of ophthalmia in rats on rations deficient in vitamin A.** *Arch. of Ophthal.*, September, 1924.

(5) **Yudkin**, with a view to examining the progressive ocular changes from a clinical and pathological standpoint, investigated the changes occurring in six groups of albino rats, 21-30 days old. The first group was fed on a mixed diet, the second, third, and fourth groups on a mixture lacking vitamin A, the fifth on the same diet except that phosphorus was also lacking, the sixth on a diet lacking vitamin A, until eye changes were well marked, when the deficiency was made up with cod liver oil or butter fat. The second group was killed when it showed excessive lacrymation and commencing photophobia, the third when fatty plaques appeared in the fornices and the cornea showed some dryness, the fourth when the cornea showed signs of breaking down. The animals were first stunned, then guillotined in order to avoid any irritating effect from anaesthesia.

The lacrymal apparatus in the rat is represented by an extra-orbital gland in front of the ear and an intraorbital gland at the outer angle of the orbit. In addition the eye is lubricated by a more viscid secretion supplied by the Harderian gland, in close apposition to the eyeball and secreting its fluid at the inner canthus.

Ocular disturbances occurred from 30-60 days after deprivation of vitamin A. The first signs were lacrymation, photophobia and a sinking back of the eye into the orbit. The lacrymal secretion then became viscid and blood-stained and dry secretion accumulated in the ocular *cul-de-sac*. The lid hairs fell out, and the lids became matted together. The cornea is unaffected in the early stages, but

later it shows some peripheral haze and yellowish fat-like patches extend on its surface. When these are removed there is no disturbance of the surface and it will not stain with fluorescein. The cornea now becomes dry, oily, lustreless, and partially opaque. Ulceration, perforation, and panophthalmitis follow if the animal does not succumb. Histologically, the earliest change was the development of small inflammatory lesions in the lid and nictitating membrane, the site of election in the lid being near the palpebral fold. The animals of group 2 had normal corneae and lacrymal glands. The Harderian gland, however, showed definite granulation and vacuolation of the cytoplasm. In group 3, proliferation of the epithelium with slight keratosis at points opposite the early lid lesions were the first changes in the cornea. The epithelium was then invaded by leucocytes and by vessels growing in from the periphery, it became thicker and the keratinized parts were thrown off. Bowman's and Descemet's membranes and the posterior endothelium were intact. The Harderian gland in groups 3 and 4 was smaller showing vacuolation and disintegration of the cytoplasm. In one case there was an acute inflammation. The acute process passed on to fibrosis and atrophy. The lacrymal glands showed no histological changes. Some cases in group 4 developed iritis and hypopyon. The changes in group 5 appeared earlier and were very severe. The keratitis for instance was of a fulminating type.

In group 6 there was almost complete regeneration of the cornea and the Harderian gland.

The author is of opinion that the protective substances in the secretion of the para-ocular glands are diminished as a result of the insufficient diet. Thus the avirulent organisms, constantly present in the conjunctival sac, are enabled to produce a progressive low-grade infection.

F. A. WILLIAMSON-NOBLE.

(6) **Gasteiger, Hugo (Innsbruck.)—On premature turning grey of the lashes.** (**Über fruhzeitige ergrauen von Zilien.**) *Arch. f. Augenheilk.*, February, 1925.

(6) Canities prematura has been found associated with sympathetic ophthalmitis, severe double irido-cyclitis, a blow on the eye, strong emotional excitement, myopia, eczematous conjunctivitis, hysteria, trachoma and migraine. It has also been noted to occur spontaneously. **Gasteiger** gives the following instance of grey cilia associated with interstitial keratitis in a boy aged 9 years. The whitened lashes were confined to the upper lids, a set of discoloured ones alternating with about double the number of normal ones. Both the normal and the abnormal offered

equal resistance to epilation. They varied in length. According to the parents of the boy the cilia suddenly turned grey within a few days of the onset of interstitial keratitis. There was nothing abnormal about the hair of the head. While it is hardly to be doubted that strong emotional excitement is sometimes followed by sudden discolouring of the lashes, it is not clear that the diseases above enumerated bring about the change. The whitening may occur suddenly or gradually. In the former case it is thought to be due to increase in the quantity of air or air-like gas in the pith of the hair; in the latter to either defective formation of pigment at the root resulting from circulatory disturbance or to defective distribution of pigment from the root to the shaft, while the air or air-like gas content of the pith cannot be left out of account altogether.

D. V. GIRI.

(7) **Watson-Williams, E., Watson-Willlams, P., Chambers, E. R., Dixon, G. C., Kingston, S. H., and Claremont, L. E. —Reports on tutocain: a local anaesthetic.** *Lancet*, May 2, 1925.

(7) These reports on the new local anaesthetic tutocain deal with its pharmacology and its application in rhinology, ophthalmology, urology and dental surgery. In the report on pharmacology by **E. Watson-Williams** the drug is described as the hydrochloride of di-methyl-amino-methyl-p-aminobenzoyl-oxybutane, having the formula $C_{14}H_{22}O_2N_2.HC$. It is related to alypin and to stovain (formulae given). It occurs as a faintly creamy-white powder consisting of microscopic crystals soluble in cold distilled water up to 12 per cent. It can be boiled for a ***short*** time without decomposition but should not be autoclaved. The solution will keep good for several days in a stoppered vessel but there must be no trace of alkali; and some glass is alkaline. Normal saline may be used to dissolve or dilute tutocain. Adrenalin may be added immediately before use. Tutocain is insoluble in oils. It is not subject to the Dangerous Drugs Acts. The author discusses the toxicity and concludes that tutocain is about three times less toxic than cocain hydrochloride and rather more than twice as toxic as novocain. "No laboratory investigations of the local effects of tutocain have been made for the purposes of this report, since the clinical evidence seemed so much more valuable."

Omitting the reports dealing with the use of this drug in rhinology, urology and dentistry, it will suffice here to mention the report on its use in ophthalmology by Chambers and Dixon. These clinicians have employed tutocain in about 100 cases. Fresh solution is advisable, the addition of salicylic acid (as a

preservative) proving too irritating. They found that for superficial work a 1 per cent. solution gave a degree of anaesthesia equivalent to that of 2 per cent. cocain, but with a rather later onset. For deep anaesthesia a 5 per cent. solution appeared to give an effect similar to 4 per cent. cocain. As regards irritation effects the weak solution is non-irritating, the stronger is slightly more irritating than cocain. There is definite injection of the conjunctiva, controllable by adrenalin. Drying of the cornea is less than with cocain. The pupil is dilated by this drug but more slowly than with cocain and to a less extent. The effect on the ocular tension is not mentioned by the authors.

ERNEST THOMSON.

(8) **Koby**, F. (Bâle).—**Diocaine: a new ocular anaesthetic particularly suitable for tonometry. (Une nouvelle anesthésique oculaire, la diocaine, particulièrement propre á la tonométrie.)** *La Clin. Ophtal.*, August, 1924.

(8) There seems to be at the present time a perfect epidemic of discovery, or perhaps one should rather say of invention, of new local anaesthetics. A very casual glance over some French literature reveals Tutocain (recently described by Watson-Williams and others in the *Lancet* for May 2), Butocain, the description of which is sulphate of paraminobenzoyledibutylamino-propanol, Scurocaine, an ether of paraminobenzoic acid, Psicaine, belonging to the cocain group is obtained by synthesis, as is the subject of this abstract. Diocaine, described by **Koby** as an allylated derivative of holocain in which the two radicles C_2H_5 of holocain are replaced by two C_3H_5 groups. The principal points about diocaine are as follow:—(1) It is soluble in water and in alcohol and can be sterilized by boiling. It is (like tutocain q.v.) precipitated if the glass vessel containing it contains alkali. Therefore it should be dissolved in boric acid (two to three centigrammes to 10 grammes of saturated solution of boric acid). (2) Anaesthetic power superior to that of holocain. Two or three instillations of 1 per cent. diocaine permit extraction of corneal foreign bodies. (3) Tension not altered at all either in the normal or glaucomatous eye. (4) Pupil and accommodation not influenced. (5) Instillation up to 1 per cent. is painless. (6) The author has made a special investigation as to action on the corneal epithelium. The slit-lamp and corneal microscope show that diocaine has no action on the corneal epithelium of the normal eye, although apparently, slight alterations of the epithelium may occur in the glaucomatous eye. (7) Diocaine does not appreciably alter the calibre of the conjunctival vessels. (8) Its toxicity to the rabbit is said by the manufacturers to be about double that of holocain, but since diocaine has greater

anaesthetic power than holocain equally active solutions have about the same toxicity.

The author suggests that for repeated instillations the strength should not exceed 2 to 3 per thousand.

ERNEST THOMSON.

(9) **Beckershaus, F. (Kiel).—Pituitary hyperplasia in pregnancy and the visual fields. (Schwangerschaftshyperplasie der Hypophyse und Gesichtsfeld.)** *Zeitsch f. Augenheilk.*, March p. 181, 1925.

(9) **Beckershaus** has gathered together a considerable bibliography on the subject of the influence of the enlargement of the pituitary during pregnancy on the visual fields and on the light sense.

He finds it incontestably established that this gland increases in weight and in size in all diameters with each successive pregnancy. His résumé of the literature shows that the most contradictory views are held on the visual effect of this enlargement. At one extreme Cavill (1923) finds a definite temporal shrinking of the fields; Beckershaus, having investigated 150 cases of pregnancy, 83 of which were examined within four weeks of labour, and of whom 95 were primiparae, and 55 were multiparae (up to the eighth pregnancy), finds that the visual fields for red and blue were diminished in one case bilaterally, and in one unilaterally on the temporal side, while the field for white was in every case unaltered. Similarly only in a negligible number of cases was the light sense impaired.

He concludes, therefore, that pituitary hyperplasia at this time has practically no influence on the visual field or on the light sense.

W. S. DUKE-ELDER.

(10) **Poynter, C. W. M. (Omaha, Nebraska).—Lens antigen as a factor in congenital and hereditary eye anomalies.** *Amer. Jl. of Ophthal.*, March, 1925.

(10) **Poynter and Allen** have performed a series of experiments in order to test the statement made by Guyer and Smith, to the effect that the injection of fowl anti-lens serum and rabbit lens emulsion into pregnant rabbits, produced abnormal eyes in the young, and further that these defects were transmissible.

Finlay, Huxley, and Carr-Saunders have already published papers reporting their failure to secure a single rabbit, rat or mouse with eye defects although Guyer's technique was carefully followed, and the result of Poynter's and Allen's investigation is the same.

Their first experiments consisted of using rat, rabbit, and sheep lenses for sensitization of fowls and injecting the fowl anti-lens

serum into pregnant white rats and rabbits. Later the sera of the fowls were tested by a complement fixation reaction and methods were adopted that gave a high measure of sensitization. Incidentally it was noticed that when a fowl's serum was rendered sensitive, say to rabbit lens protein, it also gave a positive reaction with that of an ox, sheep, pig, rat or fowl, thus furnishing additional evidence of the organ specificity and not species specificity of this protein. In not one of the experiments cited was a positive result attained. An interesting result, however, occurred in one of the control animals. This was a well-developed doe which was mated to a Belgian buck and was given 5 c.c. of salt solution intraperitoneally every three days after the tenth day of pregnancy. She had a litter of four which grew well but were unable to open their eyes. The lids were therefore opened and the conjunctival sacs were found to be filled with sterile cell debris. The corneae were atrophic and partially opaque, while the lenses were all densely cataractous; this latter condition persisted, though in two cases the cornea cleared. Later, the young all contracted snuffles and died. The doe was again mated to another buck and had a litter of five, two of which had bilateral cataract, the whole litter dying before they could be bred from. The doe was again mated but died of a brain abscess. In order to attack the subject from a different aspect, a series of twenty rats were successfully injected with the tubercle bacillus by injection into the anterior chamber. Six weeks later a complement fixation test was positive for about half of the series with both rat and rabbit lens antigen. Some of the rats died from generalized tuberculosis, but 48 of the first generation of progeny were obtained and not a single eye defect was found nor has any appeared in subsequent litters.

F. A. WILLIAMSON-NOBLE.

BOOK NOTICES

Slit-lamp Microscopy of the Living Eye. By F. E. KOBY. Translated by Charles Goulden and Clara Lomas Harris. London: J. & A. Churchill. 1925. Price 10s. 6d. net.

Two years ago the British oculist who wished to study the microscopy of the living eye was handicapped by the lack of a book dealing with the technique of the slit-lamp in a simple manner. There was nothing to be found in the journals written in English, and the German articles were quite unsuitable for one ignorant of

the elementary facts of the subject. Vogt's atlas did not pretend to give instruction in the practical details of the slit-lamp and the best methods of using it, and the English edition was out of print. The sole source of information regarding technique was Koeppe's book, but this is a ponderous work, and much reading was necessary before the few simple facts desired could be found. Koeppe's work is incomplete and out of date, for it does not include the lens, a most important chapter, and localisation with the narrow beam is not mentioned. The whole book is devoted to the pure microscopical side of the question, and even here much of Koeppe's work has not been corroborated by later workers.

The slit-lamp is not an instrument that can be used without instruction either oral or from books. Not everyone can attend a course on the slit-lamp; many are perforce restricted to the written word.

Koby's book fills the gap, and will be received with gratitude by a large number of ophthalmologists anxious to take advantage of the latest method of examining the eye. Those who do not read French fluently owe a debt to Mr. Goulden and Miss Harris for the labour they have expended in rendering Koby's work into English.

We have nothing but praise for the manner in which Koby has treated a difficult subject. He has presented us with a clear explanation of the theory and practice of slit-lamp microscopy, and his book, together with Vogt's atlas, will enable many to master the instrument even without oral instruction, although it is very desirable to obtain practical help whenever possible.

The sole criticism we make is that we feel that the author has not been quite fair to the methods of examining the deeper parts of the vitreous, the iridic angle, and the retina, with the aid of the contact-glass and a modified slit-lamp. It is not necessary to use a microscope with a single objective: by suspending the slit-lamp from a suitable gallows Gallemaerts and Kleefeld have been able to utilize the ordinary microscope. I have had the opportunity of seeing the apparatus in use at Brussels. Dr. Kleefeld called an ordinary refraction case, a girl of about 18. He slipped the contact glass in without any cocain and we were able to obtain a perfect view of the retina with the ordinary nitra lamp. The patient assured us that she did not feel the slightest discomfort. The gallows costs about £5 and can be adjusted to the ordinary apparatus without alteration. A special mirror is necessary. Koeppe has written a long book describing the minute anatomy of the retina as seen by this method and probably not all that he describes is wholly devoid of value.

Chapter I deals with the construction of the slit-lamp and the eye microscope and describes them in simple language without any complicated optics. The original Gullstrand setting is explained

and is contrasted with the modern Vogt adjustment. It is only rarely that Gullstrand's method is employed. The path of the rays is shown by photographs.

Chapter II, a very important one, considers the various methods of illumination, and discusses the vital subject of localisation.

Chapter III is devoted to the phenomena of reflexion from the ocular surfaces and contains interesting photographs of the catoptric images from the cornea and lens. Attention is drawn to the projection of shadows. This chapter is mainly theoretical but is of importance, for confusion may result from failure to recognise these reflected images.

Chapter IV begins the practical clinical side of the work with a study of the normal and modified conjunctiva.

Chapter V is given over to the cornea, normal, senile and diseased, and to the description of the corneal "prism." This we consider to be a better term than that chosen by the translators "parallelepiped." This is an awkward mouthful. Naturally the illuminated block is not really a prism nor is it a true parallelepiped. The literal translation of the German "prisma" is more euphonious and has received general acceptance.

The normal cornea, the changes that take place in old age, and the various pathological conditions, receive adequate attention. Of especial interest is the full account of the various types of pigmentation in the cornea including that rare condition, the Kayser-Fleischel ring in Kinnier Wilson's disease.

Chapter VI contains important details regarding the anterior chamber with its normal and abnormal contents and the convection currents of the aqueous.

Chapter VII deals with the iris. The normal iris with the changes met with in senility and disease are described.

We rather regret that the translators have decided to use the term "collarette" as an equivalent of the French "collerette," and for two reasons. One is that we have a sound English word "frill" which is an exact translation and fully meets the case. Another is that some Belgian writers have employed the French word to describe the pupil margin and so there is an element of confusion. In the circumstances it seems better to abandon collarette and call the region of the circulus minor the "frill." While upon the subject of translation we may point out that the word "lustre" does not generally suggest the appearance seen in a cat's eye. We feel that "*chatoie*" would be better rendered as "iridescence" which implies colour, rather than as "lustre," which in its common use suggests brightness and splendour. When a lady's eyes are called "lustrous" the comparison with the feline organ is not implied. We hope that the translators will forgive these minor criticisms of their painstaking labour.

Chapter VIII unfolds the modern conception of the anatomy of the lens introducing the reader to the zones of discontinuity, the reflecting surfaces, and the suture systems. In reading this chapter we regret that the great cost of illustrations has precluded their extensive use in circumstances where they would be very valuable. Various types of cataract are noted, many of recent discovery. The slit-lamp has compelled us to reclassify cataract and many new varieties have appeared. We draw attention to those associated with nervous disease, Mongolian idiocy, myotonia atrophica, and the like. The special form due to the retention of copper in the eye is described and illustrated.

Chapter IX completes the book with a full account of the normal and degenerating vitreous. Our knowledge of the changes that occur in old age is due almost entirely to the slit-lamp and the fact that infiltrations are seen in the vitreous some days before more general signs of sympathetic ophthalmitis is one of the most precious gifts afforded us by the new instrument.

Koby's work should be read by all ophthalmic surgeons whether they use slit-lamps or not, for the book is full of new facts and describes methods of illumination which are not confined to the slit-lamp but can be employed with far humbler apparatus.

T. HARRISON BUTLER.

The Extra Pharmacopoeia. By MARTINDALE & WESTCOTT. 18th edition. Vol. II, 8vo, pp. 42 and 728. London: H. K. Lewis & Co., Ltd. *1925.* *Price 20s. net.*

The first volume of this invaluable work was noticed in our pages in January of this year, p. 41. The second volume deals with analytical, experimental and research work. It contains a mass of facts, and though perhaps not so useful to the busy practitioner as the first volume, its preparation must have entailed an enormous amount of work, and with the daily increase in importance of biological chemistry in medicine, its value to the research worker will be undoubted. We, as ophthalmic surgeons, will sympathize with the authors in their statements in the preface, under cocain—"We have no interests in the manufacture of cocain, but we fail to see why there should be any interference with its correct medicinal use."

CORRESPONDENCE

THE USE OF A CYLINDER IN THE SLIT-LAMP OPTICAL SYSTEM

To the Editor of THE BRITISH JOURNAL OF OPHTHALMOLOGY

SIR,—I see that Dr. Koby, in his book on "Slit-Lamp Microscopy of the Living Eye," refers on page 13 to "The Astigmatic Beam of the Author," quoting an article by himself on the subject in *Rev. gén d'Ophtal.*, 1925, and the necessary appliance as having been made for him by the Optical and Mechanical Works, Basle. It is a matter of no importance, but the coincidence of this independent suggestion of Dr. Koby's is, incidentally, not the first. Towards the end of 1923, I experimented with the use of a plano-convex cylinder for creating an astigmatic light-bundle, and Messrs. Atha & Co., in London, were kindly of assistance to me in the matter. At the beginning of 1924, I communicated the design for such a cylinder, together with plans of other devices, to Dr. O. Henker, Director of Messrs. Zeiss's Med. Optical Dept. In the summer of 1924, Dr. Henker showed me and furnished the model which it was proposed should be supplied in accordance with my specification. My cylinder is mounted on a hinged support by which it is attached to, so that it can always remain on, the slit-lamp arm; once the axis has been adjusted—and this must be done critically—the cylinder can be turned in or out of position with ease according as its use may be desired or not. If I may say so the fitting of such a cylinder into the end of the Koeppe tube, as Dr. Koby has done, is not very suitable for various reasons, one being that every time the cylinder is replaced for use the careful checking of the axis-adjustment must be repeated. A special independent simple diaphragm for attaching to the slit-lamp arm, abolishing the necessity to possess the Koeppe diaphragm, is made for use with or without my cylinder attachment.

In November, 1924, I sent the following typed instructions to Messrs. Zeiss to issue for use with my cylinder—

"(1) Adjust the slit-lamp in the usual way, so that the image of the lamp filament is in sharp focus on the diaphragm of the focussing lens.

(2) Put the cylinder-attachment on the slit-lamp arm a little in front of the mid-point between the slit and the focussing-lens, with the plain surface facing the slit. Turn the cylinder down (*i.e.* horizontal) out of the path of the rays whenever it is desired to adjust the focussing of the filament-image on the focussing-lens.

(3) With the cylinder in position, make the slit very narrow and examine, through the microscope (Oc. 2, Obj. A2) the narrow corneal stripe, or the anterior lens-capsule stripe. If these cannot

be formed in sharp focus, rotate the cylinder in its mount, whilst still looking through the microscope, until the slit-images, focussed in the eye are seen sharply defined.

(4) Use the attachment with the 7.0 or 10.0 focussing-lens for the cornea and anterior chamber. With the 7.0 cm. lens the length of the slit-image stripe falls a little short of the full diameter of the cornea. For the examination of the cornea and anterior chamber it is advantageous to use the F55 objectives in conjunction with the cylinder-attachment in order to detect abnormal curvatures of the cornea and abnormalities of the chamber-depth—local or general. The image-stripe on the iris and lens forms thus an arc to the curved image-stripe on the cornea, like the string to a bow.

(5) For the separation-lines of the lens-zones the cylinder-attachment gives the best effect with the 7.0 cm. focussing lens. A comprehensive view which, when the pupil is dilated, includes the periphery of the lens-zones is obtained by its use. Critical focussing is of course necessary, especially when the 7.0 cm. lens is used."

In December, 1924, Messrs. Zeiss despatched to the United States six such cylinders, with special diaphragms, for my use in the Department of Ophthalmology, Graduate School of Medicine, University of Pennsylvania.

Yours truly,
BASIL GRAVES.

LONDON.

NOTES

Appointments

THE following appointments have been made to St. Paul's Eye Hospital, Liverpool:—*Honorary Surgeons*: P. Eldon Gorst, F. C. Plummer, Basil Graves; Honorary Assistant Surgeons: H. R. Bickerton, E. Nicholas Hughes, I. H. Moorhouse.

Mr. F. G. THOMAS has been appointed additional Medical Referee under the Workmen's Compensation Act to take ophthalmic cases arising in the County Courts in Circuits Nos. 24, 30, and 31.

Mr. D. V. GIRI has been appointed Hon. Surgeon to the Royal Eye Hospital, Eastbourne.

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Index

IT has been decided for the future that the annual index shall be issued with the December number. This will involve the postponement of the day of issue to subscribers from December 1 to December 7 or thereabouts.

Addendum

REFERRING to the paper on "Cyst of the Iris" in the September number, p. 454, Major R. E. Wright sends us the following note:—Since forwarding the above for publication it has been brought to my notice that Schöler described a similar procedure in 1911. It is not unlikely that others also have employed methods of this type. A year after operation (August, 1925) there was no recurrence of the cyst and the condition of the eye was perfectly satisfactory.

FUTURE ARRANGEMENTS

1925

November 6.—North of England Ophthalmological Society at Leeds.

November 13.—Royal Society of Medicine, Section of Ophthalmology.

December 4.—North of England Ophthalmological Society at Bradford.

December 11.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

1926

January 8.—Royal Society of Medicine, Section of Ophthalmology.

February 5.—North of England Ophthalmological Society at Liverpool.

February 12.—Royal Society of Medicine, Section of Ophthalmology.

March 5.—North of England Ophthalmological Society at Sheffield.

March 12.—Royal Society of Medicine, Section of Ophthalmology (Clinical).

May 14.—Royal Society of Medicine, Section of Ophthalmology.

June 11.—Royal Society of Medicine, Section of Ophthalmology (Annual).